

A Comparative Analysis of Local Climate Change Adaptation Plans for Natural Disaster Risk Reduction in South Korea

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Abstract: As abnormal weather phenomena due to climate change globally continues, the frequency of natural disasters and human and economic losses from floods, typhoon, heatwaves and heavy snow are constantly increasing in South Korea. For the last ten years (2008~2017), the total disaster damage cost was expected to be about \$3 billion in South Korea. In response, South Korea established climate change adaptation plans based on the Low Carbon and Green Growth Act enacted in 2010. Local governments adopted detailed implementation strategies to mitigate and adapt climate change based on water management, energy, health and natural disaster management since 2011. This study compared 218 local climate change adaptation plans regarding natural disaster reduction strategies. Using content analysis, this study evaluated natural disaster reduction strategies based on natural disaster types and the stage of disaster management. Moreover, this study examined the regional differences in priorities of natural disaster risk reduction strategies to implement through spatial analysis. The result of the analysis shows that the local climate change adaptation plans are mainly focused on the improvement and reinforcement of physical structures to prevent damage from typhoon and heavy rain in South Korea. This study is expected to provide keys and knowledge for basic local governments to establish the next climate change adaptation implementation plan.

Keywords: climate change, natural disasters, local climate change adaptation plan, South Korea

Introduction

Climate change is perceived as a global issue. The phenomenon affects various sectors such as healthcare, environment and energy, and is becoming even more intense. In 1990, when the IPCC First Assessment Report was issued, the main concern was to determine the existence and impact of climate change. However, as climate change incurred various environmental changes, the approach to alleviating the impact of climate change has been expanded to the approach to adapt since the 2000s (Kim et al., 2014). Furthermore, the IPCC emphasized the importance of ‘climate change adaptation’ in the Fourth Assessment Report in 2007.

Climate change causes an extremely cold climate and incurs severe property and human damages in fields such as healthcare, infrastructures, ecosystem, agriculture, etc. In particular, Korea is suffering damages every year due to heat and cold waves, local heavy

rains and typhoons caused by climate change. Thus, the government is establishing climate change adaptation policies to reduce damages from climate change and improve the adaptation capacity of each local government. The 'Climate Change Adaptation Action Plan' as a plan to adapt to climate change is established at the national level, as well as in the upper-level and lower-level local governments. Currently the central government and upper-level local governments established the 1st Plan in 2012 and then the 2nd Plan in 2016. Lower-level local governments have begun to establish the 1st Plan in 2013 considering the circumstances of each region, and currently all lower-level local governments except four regions have completed the establishment of the plan. In addition, the central government is advising each region to revise and improve the details of the plan in light of the climate change policy implementation details every year. However, the revisions have not been properly assessed, and it turned out that there are still certain inadequacies in terms of content (Kim et al., 2014).

Accordingly, the present study conducts a content analysis on the details of the Climate Change Adaptation Action Plan of 221 lower-level local governments in Korea, and suggests matters to improve for effective establishment and implementation of the climate change adaptation plan.

Literature Review

Planning may perform the role of supporting decisions for public interests under complicated circumstances, and its level may vary depending on the purpose and contents of the plan, or the conditions and circumstances in which the plan is established (Hopkins, 2001). In other words, it is important to analyze the contents of the plan since it is essential for the right function of planning to operate properly. Moreover, it is also important to analyze whether the plan can effectively deal with the uncertain future (Berke et al, 2012), and also whether it includes the optimum strategies to accomplish the goal of planning (Wildavsky, 1973).

Studies that analyzed planning mostly defined its success or failure, and are evaluating plans by organizing evaluation principles and indexes. Most previous studies evaluated planning based on content analysis, and the evaluation principles and indexes used in each study were based on a basic evaluation framework.

Alexander et al. (1989) conceptualized the evaluation criteria to distinguish 'good' and 'bad' planning, and presented an evaluation system utilizing the criteria. They presented the policy-plan/programme-implementation-process (PPIP) model for evaluation of planning and detailed criteria for evaluation such as conformity, rational process, optimality ex ante, optimality ex post, and utilization. Brody (2003) evaluated the plan to mitigate national hazards using content analysis. He provided three evaluation principles such as fact base, goals, and action, and evaluated the plan by developing detailed evaluation indexes. Berke et al. (2005) presented an evaluation method focused on plan implementation to resolve the issue of evaluation focused on contents. They defined successful planning as 'how well plan implementation is done', and developed detailed items such as plan equality, enforcement style and awareness building. Baynham et al. (2012) used content analysis to evaluate the climate change action plan in terms of adaptation and reduction. They presented fact base, goals, policies, and implementation as the evaluation principles, and used detailed indexes for evaluation. Baker et al. (2012) used multi-criteria analysis to evaluate the climate change plan. They focused on planning-based policies rather than the contents of the plan, or the improvement level through business, and used total 8 evaluation criteria for evaluation. Berke et al. (2012) conducted research on evaluation of the coastal hazard mitigation plan using content analysis. They divided evaluation principles into internal and external indexes, presenting goal, fact base, mitigation policy, and implementation and monitoring for the internal indexes and interorganizational coordination and participation for the external

indexes. Lyles et al. (2014) used content analysis to evaluate the local hazard mitigation plan. They divided evaluation principles into direction-setting and action-oriented principles, with presenting goal, fact base, and policies for the direction-setting principles and participation, inter-organizational coordination, implementation, and monitoring for the action-oriented principles. Kim et al. (2014) evaluated the Climate Change Adaptation Action Plan of 16 upper-level local governments in Korea using the logic framework analysis (LFA). They presented 4 evaluation principles such as goals, fact base, decision making, and implementation and evaluation, and evaluated the plan using 17 detailed evaluation indexes.

As a result of the literature review, it was found that previous studies were organizing the principles of evaluation based on the components of the plan contents. General components of contents are comprised of fact based analysis, vision/goal setting, policy establishment, implementation and maintenance planning, and participation planning. Previous studies defined 'fact base analysis' and 'vision/goal setting' all equally as 'fact base' and 'goal' (Baynham et al, 2012; Berke et al, 2012; Brody, 2003; Kim et al, 2014; Lyles et al, 2014), but defined 'policy establishment' in different ways such as 'policy' (Baynham et al, 2012; Lyles et al, 2014), 'mitigation policy' (Berke et al, 2012), and 'decision' (Kim et al, 2014). They also defined 'implementation and maintenance planning' as 'implementation' (Baynham et al, 2012; Lyles et al, 2014), and also considered 'monitoring' (Berke et al, 2012) or 'evaluation' (Kim et al, 2014), or even newly defined it as 'action' (Brody, 2003). They defined 'participation planning' by considering both 'participation' and 'inter-organizational coordination' (Berke et al, 2012, Lyles et al, 2014).

Moreover, most evaluations were focused on the contents, and also outcomes of planning as well. In other words, previous studies conceptualized the success of planning as the adequacy of content and performance. That is, previous studies mostly analyzed and evaluated the contents of planning using content analysis with regard to the adequacy of contents, and empirically analyzed and evaluated the possibility and outcomes of planning and plan implementation with regard to the adequacy of performance. In this aspect, this study is an evaluation focused on the contents of a plan, and is differentiated from previous studies as it evaluates the climate change plan in terms of disasters.

Climate Change Adaptation Plan (CCAP) in Korea

Korea is establishing the Climate Change Adaptation Action Plan as a means to improve the adaptation capacity of the nation and local governments to climate change. The Climate Change Adaptation Action Plan is a five-year plan established at the level of the nation as well as upper-level and lower-level local governments. The government enacted the Framework Act on Low Carbon, Green Growth in 2010 as well as its Enforcement Decree, and made planning mandatory by law.

The government established the 1st National Climate Change Adaptation Plan in 9 sectors such as public health, water management and agriculture in 2011. Based on the above, the Action Plan for each of the local governments was established: upper-level local governments since 2012, and lower-level local governments since 2013. Then in 2016, the 2nd National Climate Change Adaptation Plan was established based on adaptation as well as economic, social and environmental sectors. Accordingly, upper-level local governments established their 2nd plan, whereas lower-level local governments still only have the 1st plan considering their regional circumstances.

Table 1. Changes in the National Climate Change Adaptation Plan

Division [↗]	1 st National Climate Change Adaptation Plan(2011-2015) [↗]	2 nd National Climate Change Adaptation Plan(2016-2020) [↗]
Sector [↗]	<ul style="list-style-type: none"> • Carry forward adaptation measures for each of the 9 sectors[↗] 	<ul style="list-style-type: none"> • Establish an integrated adaptation system based on adaptation as well as economic, social and environmental sectors [↗]
Paradigm [↗]	<ul style="list-style-type: none"> • Present only the need for measures in each sector to accomplish the long-term vision [↗] 	<ul style="list-style-type: none"> • Differentiate mid/long-term and short-term visions and goals for climate change adaptation at the national level [↗]
	<ul style="list-style-type: none"> • Develop and carry forward measures limited to climate change adaptation [↗] 	<ul style="list-style-type: none"> • Create joint benefits by considering both climate change reduction and adaptation[↗]
Content [↗]	<ul style="list-style-type: none"> • Preferentially select the measures carried forward by each department [↗] 	<ul style="list-style-type: none"> • Establish scientific and demand-based measures based on climate change impact and risk evaluation [↗]
	<ul style="list-style-type: none"> • Parallel structure of measures in each sector[↗] 	<ul style="list-style-type: none"> • Set priorities and key strategies of adaptation in each sector and promote a virtuous cycle of economy, society and environment with climate change adaptation [↗]
	<ul style="list-style-type: none"> • Obtain relevance with government keynote and higher-level plans [↗] 	<ul style="list-style-type: none"> • Secure consistent direction with the value of the policy by establishing climate change adaptation principles [↗]
Implementation	<ul style="list-style-type: none"> • Inspect whether measures are carried forward regularly[↗] 	<ul style="list-style-type: none"> • Strengthen implementation and inspection systems [↗]

Methodology

Subjects

The present study analyzed the contents of the Climate Change Adaptation Action Plans of lower-level local governments in Korea. To this end, the subjects were the Climate Change Adaptation Action Plan of 221 out of 226 lower-level local governments, excluding 4 regions that did not establish the plan (Dongdaemun-gu of Seoul, Ongjin-gun of Incheon, Dong-gu of Daejeon, Jangsu-gun of Jeonbuk) and 1 region from which data could not be obtained (Yanggu-gun of Gangwon).

Analysis method

The analysis process of this study is as follows: 1) data organization, 2) coding of a detailed plan, 3) comparative analysis by region and disaster type, and 4) correlation analysis between disaster damage and plan contents.

To begin with, to analyze the disaster plan in the Climate Change Adaptation Action Plan, this study came up with total 1,684 detailed plans by organizing data based on content analysis. Then, this study set the dimensions for coding of detailed plans, with reference to the principles used in previous studies for evaluation as well as the components of the climate change plan in Korea.

The Climate Change Adaptation Action Plan in Korea is comprised of overview, climate change adaptation status and forecast, goals and detailed strategies, action plans for each field, plan implementation and management. The overview of the plan includes contents about the background and

purpose of planning, basis, and establishment procedures. The climate change adaptation status and forecast include vulnerability analysis on climate change. The goals and detailed strategies include visions, goals and detailed strategies to achieve them. The action plans for each field include the details of the adaptation plan, and plan implementation and management include specific details of implementation such as plan, schedule and budget as well as future management plans.

Previous studies are using fact base, goal, policy, implementation, and participation as the basic framework of plan content evaluation. In association with the Climate Change Adaptation Action Plan in Korea, fact base refers to the overview and climate change adaptation status and forecast, goal refers to goals and detailed strategies, policy refers to action plans for each field, and implementation and participation refer to plan implementation and management. This study ultimately used fact base, goal, policy, and implementation & participation as the dimensions for the content analysis of the Climate Change Adaptation Action Plan in Korea.

Next, the present study provided the operational definition of each dimension. Fact base is defined as ‘Which of the physical, socioeconomic, and institutional vulnerability due to climate change is considered in priority?’. Goal is defined as ‘Is the action plan establishing climate change adaptation and reduction measures considering environmental factors?’. Policy is defined as ‘Is the action plan a structural measure or a non-structural measure?’. Implementation & participation is divided into the point of plan implementation and participation. The point of plan implementation is defined as ‘When is the policy established in the action plan implemented: before, during or after a disaster?’ and participation is defined as ‘Does the action plan consider participation?’. Table 2 below shows the operational definition of each dimension. Based on the definitions, this study coded each action plan, after which it conducted a comparative analysis by region and disaster type and analyzed the correlation between disaster damage and plan contents. Finally, this study came up with the tendency of the contents of the Climate Change Adaptation Action Plan in Korea based on the analysis.

Table 2. Operational definition of each dimension

Dimension [↗]	Operational definition of dimension [↗]	Criteria [↗]	Code [↗]
Fact base [↗]	Which of the physical, socioeconomic, and institutional vulnerability due to climate change is considered in priority? [↗]	Physical vulnerability [↗]	P [↗]
		Socioeconomic vulnerability [↗]	SE [↗]
		Institutional vulnerability [↗]	I [↗]
Goals [↗]	Is the action plan establishing climate change adaptation and reduction measures considering environmental factors? [↗]	Based on the environmental aspect [↗]	EO [↗]
		Not based on the environmental aspect [↗]	EX [↗]
Policies [↗]	Is the action plan a structural measure or a non-structural measure? [↗]	Structural measure [↗]	S [↗]
		Non-structural measure [↗]	NS [↗]
Implementation & Participation [↗]	When is the policy established in the action plan implemented: before, during or after disaster? [↗]	Before disaster [↗]	1 [↗]
		During disaster [↗]	2 [↗]
		After disaster [↗]	3 [↗]
	Does the action plan consider participation? [↗]	Based on participation [↗]	PO [↗]
		Not based on participation [↗]	PX [↗]

Analysis & Result

National-level analysis results of the Climate Change Adaptation Action Plan

<Figure 1> shows the national-level analysis results of the planning ratio of each dimension. The results showed that the Climate Change Adaptation Action Plan of lower-level local governments were not based on the environmental aspect. Physical vulnerability was analyzed as most important, followed by the institutional and socioeconomic vulnerability. Most plans had policy-related plans carried out before disaster, while participation is barely considered. In addition, there was almost an equal distribution of the ratio of planning related to the structural and non-structural measures in terms of the policy. This implies that the Climate Change Adaptation Action Plan in Korea does not consider the environmental aspect and participation overall, includes policies for before disaster considering physical and institutional vulnerability, and has an equivalent distribution of structural and non-structural measures.

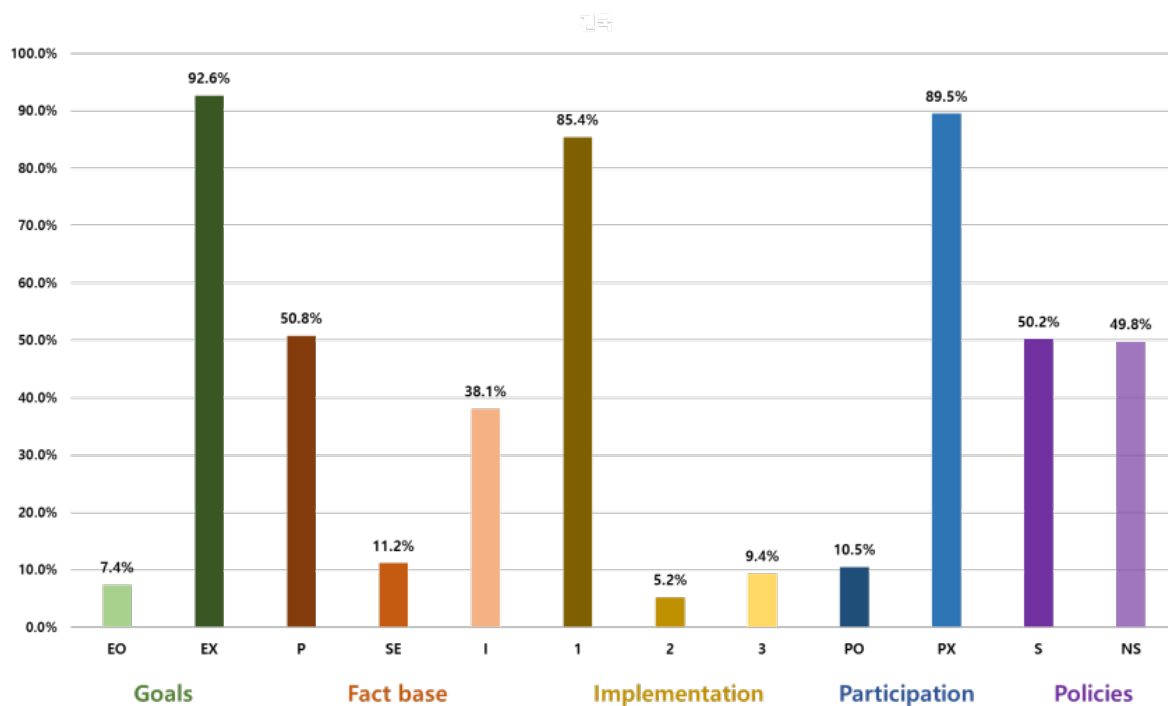


Figure 1. National Climate Change Adaptation Action Plan content analysis

Analysis results of the Climate Change Adaptation Action Plan by region

<Figure 2> shows the results of the comparative analysis on fact base by region. The results showed that physical vulnerability was considered most important in each region, followed by the institutional and socioeconomic vulnerability. Socioeconomic vulnerability was not considered important in all regions, and the ratio was lowest at 4.4% in Jeollabuk-do. This result indicates that the vulnerability factors considered important vary among regions depending on the current state of disaster vulnerability and circumstances, but they share the similarity that all regions did not consider socioeconomic vulnerability as an important factor.

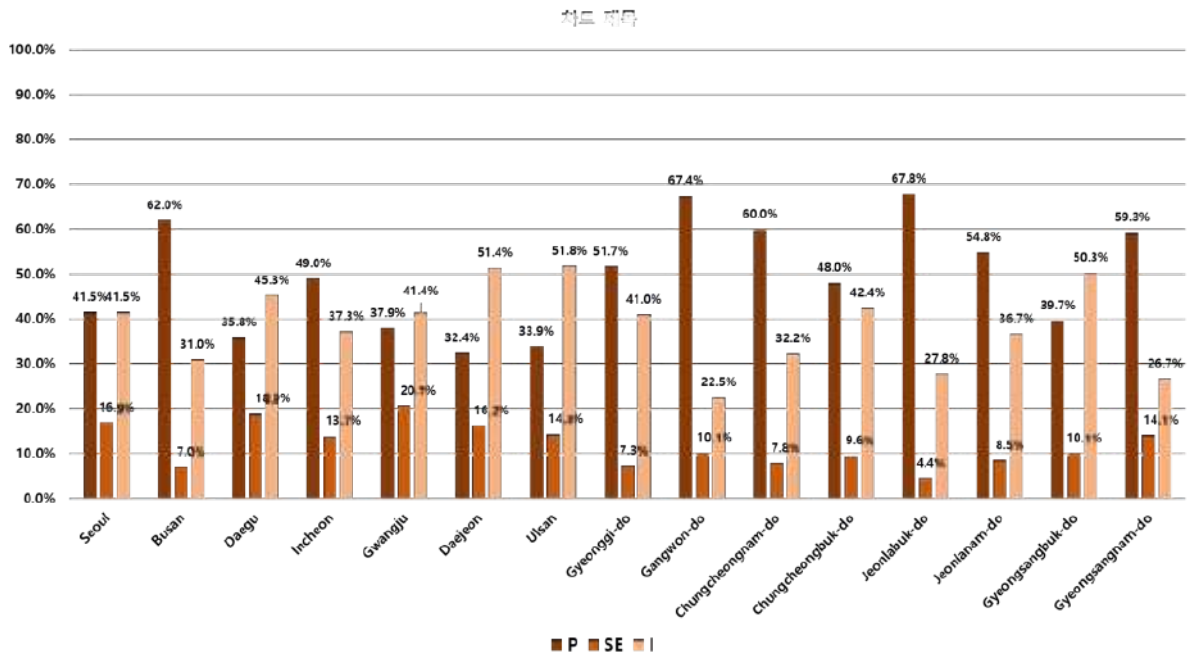


Figure 2. Content analysis of the Climate Change Adaptation Action Plan by region (Fact base)

<Figure 3> shows the results of the comparative analysis on goal by region. The results showed that all regions were establishing plans almost without considering the environmental aspect. In particular, Gwangju and Daejeon did not establish any plan that considered the environmental aspect. This result implies that all regions did not perceive the environmental aspect as an important factor of climate change adaptation.

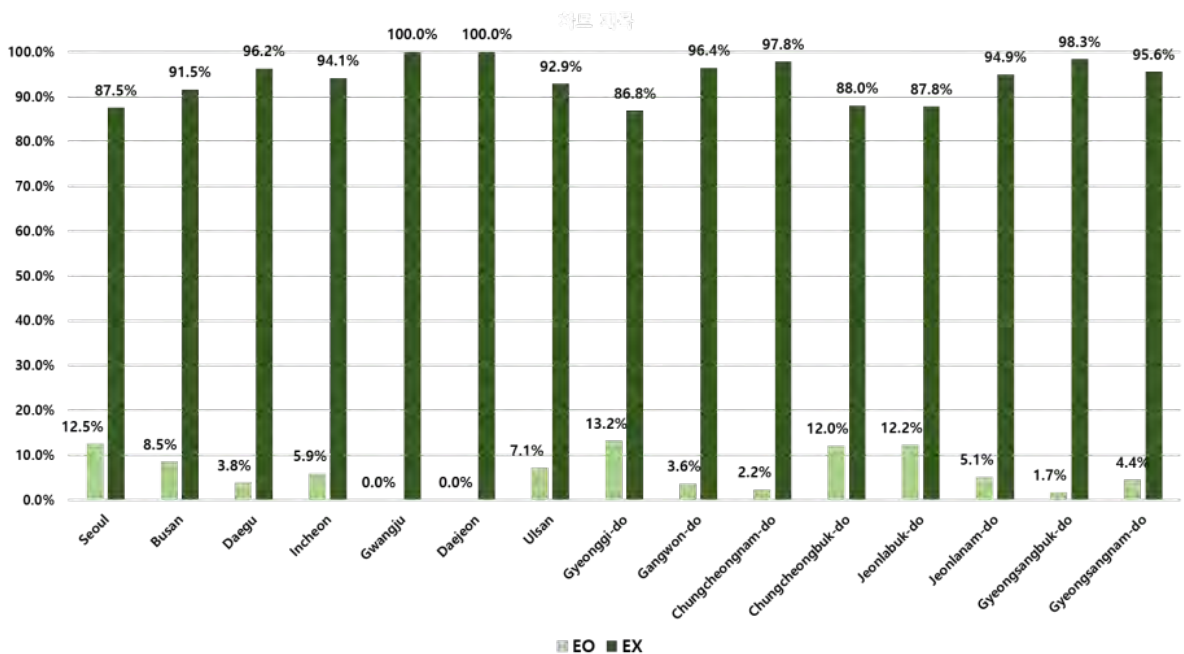


Figure 3. Content analysis of the Climate Change Adaptation Action Plan by region (Goal)

<Figure 4> shows the results of the comparative analysis on policy by region. The results showed that there were relatively more regions that utilized more no-structural measures. Structural measures accounted for a high ratio in Busan, Gangwon, Chungnam, Jeonbuk and Gyeongnam, while non-structural measures accounted for a high ratio in Seoul, Daegu, Incheon, Gwangju, Daejeon, Ulsan, Gyeonggi, Chungbuk, Jeonnam, and Gyeongbuk. This result implies that the regions were establishing policies suitable for them considering disaster vulnerability status and circumstances, and adopting structural or non-structural measures accordingly.

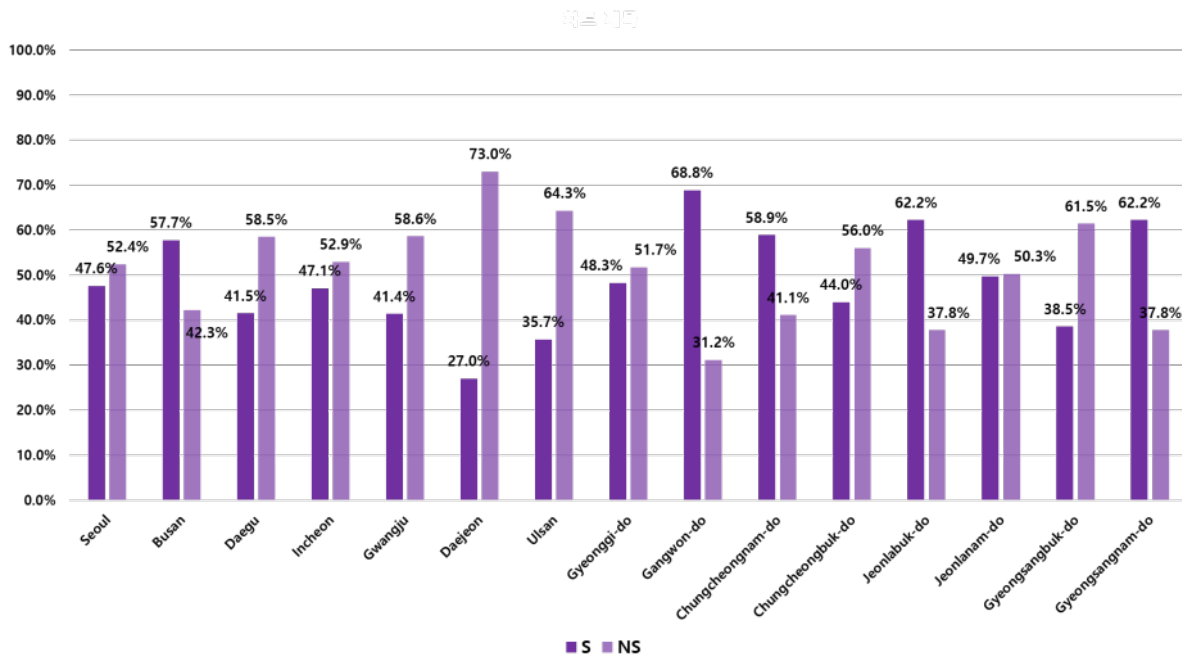


Figure 4. Content analysis of the Climate Change Adaptation Action Plan by region (Policies)

<Figure 5> shows the results of the comparative analysis on implementation and <Figure 6> on participation by region. The results showed that all regions mostly established plans related to policies for before disaster. Moreover, there were relatively fewer plans related to policies required during disaster, and Gwangju in particular did not establish any relevant plan at all. As for participation, all regions were mostly establishing plans that did not consider participation, with Gyeongnam showing the lowest ratio of participation at 3.7%. This result implies that all regions were laying more stress on the role of related institutes and organizations than participation in terms of the Climate Change Adaptation Plan, and focusing on reducing damages through prevention like the conventional disaster management plans.

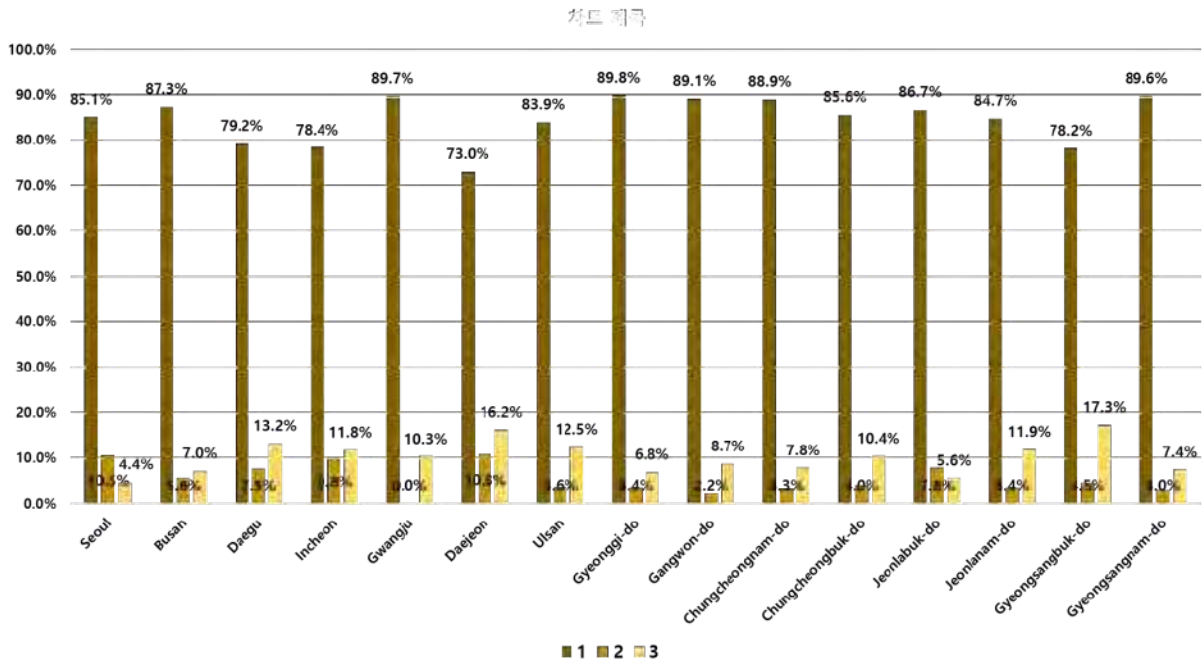


Figure 5. Content analysis of the Climate Change Adaptation Action Plan by region (Implementation)

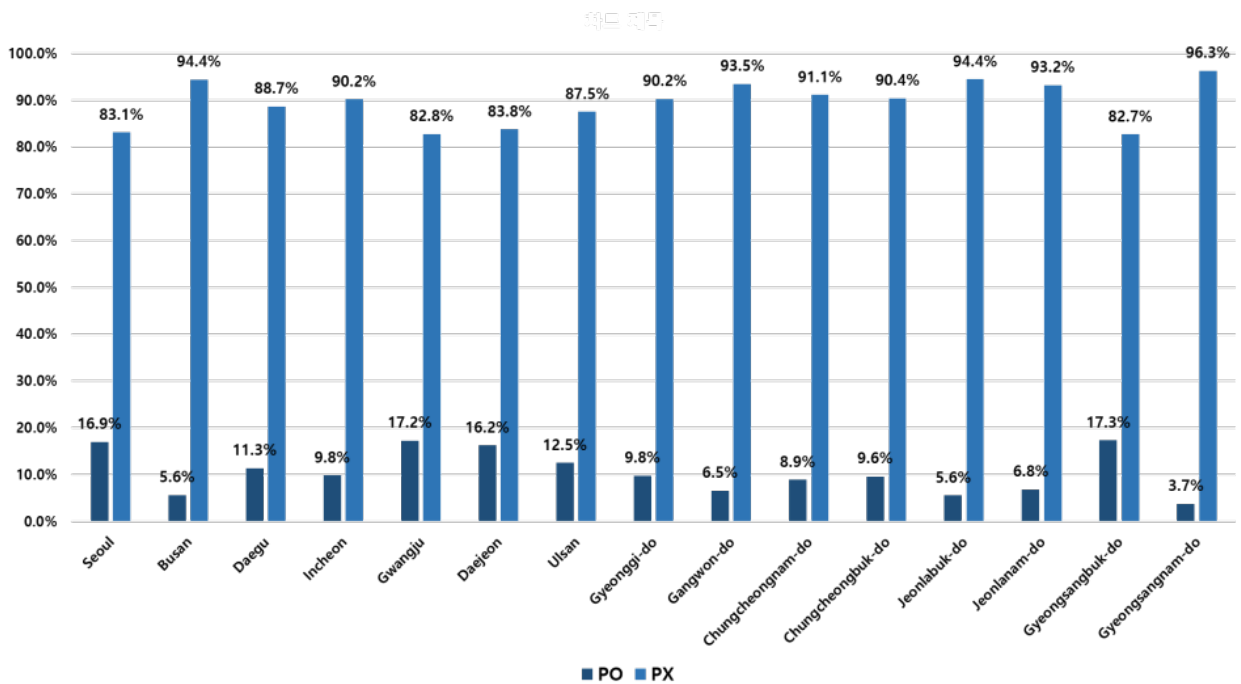


Figure 6. Content analysis of the Climate Change Adaptation Action Plan by region (Participation)

Analysis results of the Climate Change Adaptation Action Plan by disaster type

For comparative analysis by disaster type, this study came up with 12 types of disasters such as general, flood, heat wave, cold wave, typhoon, landslide, heavy snow, etc. focusing on disasters covered in the disaster sector of the Climate Change Adaptation Action Plan.

<Figure 7> shows the results of the comparative analysis on fact base by disaster type. The results showed that disasters that considered physical vulnerability as important were damages from storms and floods such as flood, typhoon, landslide, sea wave, tsunami, etc. as well as a heat wave. Disaster types that considered institutional vulnerability were general, heavy snow, and cold wave, and socioeconomic vulnerability was considered most important in cold wave and combined. In other words, socioeconomic vulnerability was considered the least by disaster type, and not considered at all in typhoon, wildfire, sea wave and tsunami. This result implies that disaster policies for damages from storms and floods and heat wave due to climate change were mostly plans to reduce physical vulnerability. For disaster policies in the winter, plans to reduce institutional and socioeconomic vulnerability were being established. On the other hand, socioeconomic vulnerability was not much considered.

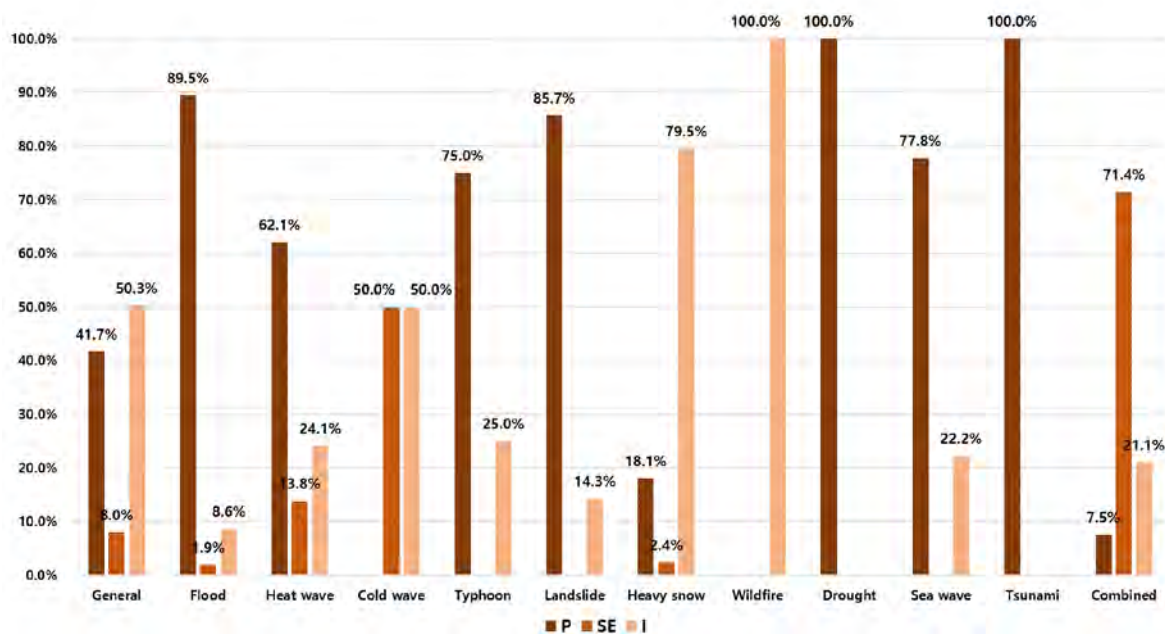


Figure 7. Content analysis of the Climate Change Adaptation Action Plan by disaster type (Fact base)

<Figure 8> shows the results of the comparative analysis on goal by disaster type. The results showed that action plans were established in all disaster types except drought without considering the environmental aspect. There were no plans at all considering the environmental aspects for cold wave, wildfire and tsunami, and the percentage of considering the environmental aspects was approximately 3.6% even in the landslide disaster that requires environmental consideration. On the other hand, all plans of drought were established considering the environmental aspects. This result implies that most disaster types were adopting climate change policies without considering the environmental aspects, even in disaster types in which they can be sufficiently considered. In other words, like the analysis results by region, the environmental aspect was not perceived as a major factor to consider in the Climate Change Adaptation Plan in Korea.

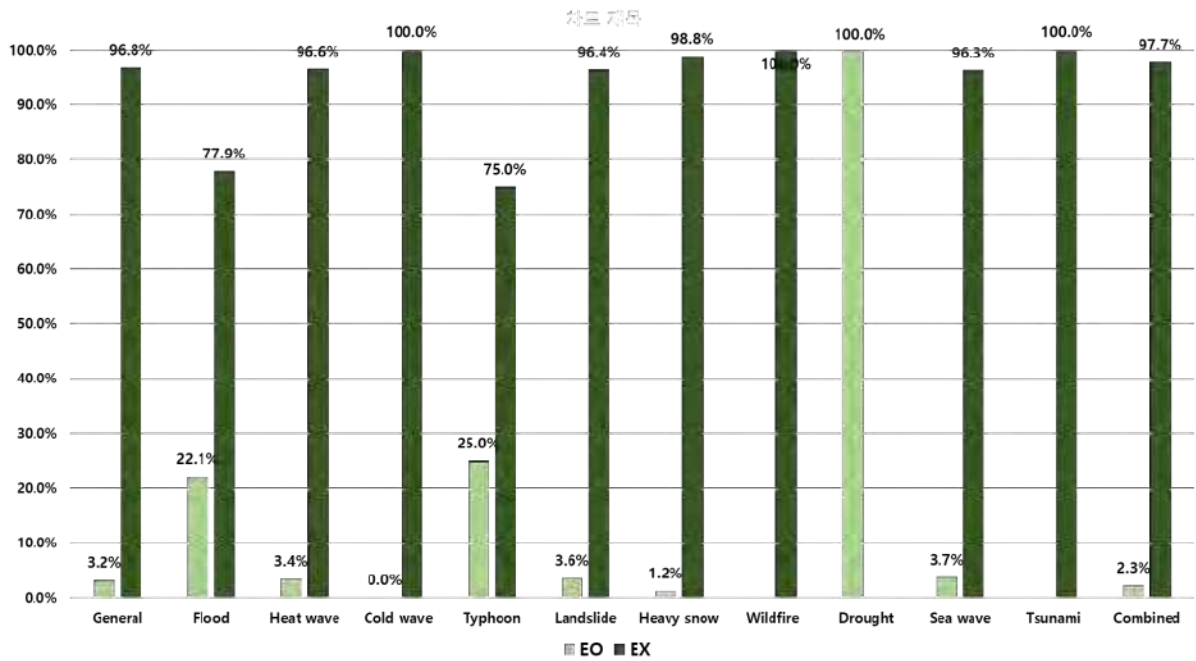


Figure 8. Content analysis of the Climate Change Adaptation Action Plan by disaster type (Goal)

<Figure 9> shows the results of the comparative analysis on policy by disaster type. The results showed that there were more disaster types using structural measures than non-structural measures. Yet, there was a difference in methods adopted based on the characteristics of each disaster type. For example, disasters such as flood, typhoon, sea wave, landslide, etc. mostly adopted structural measures, whereas heat snow mostly adopted non-structural measures. This result implies that methods that can effectively deal with disasters were adopted for each disaster type, which tends to be similar to the plan contents that had been traditionally established in disaster management planning.

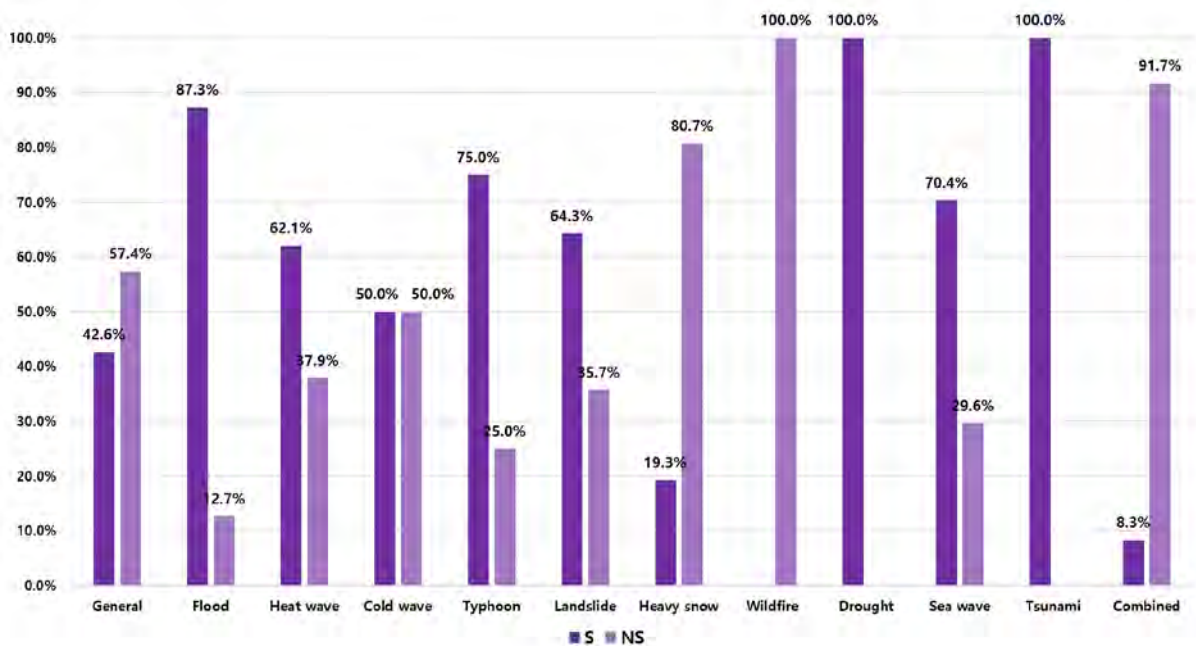


Figure 9. Content analysis of the Climate Change Adaptation Action Plan by disaster type (Policies)

<Figure 10> shows the results of the comparative analysis on implementation and <Figure 11> on participation by disaster type. The results showed that plans related to policies before disaster accounted for the highest ratio in most disaster types, while plans related to during and after disaster accounted for a relatively lower ratio. In particular, most plans had policies before disaster established for flood, typhoon, landslide, wildfire, drought, and tsunami. In the combined disasters, plans related to policies after disaster took up the biggest portion. As for participation, climate change plans that are not considering participation were established in all disaster types. In particular, participation was not considered at all in all disaster types except general, flood, heavy snow, and combined. This result implies that participation is almost not considered in the climate change plan contents of all disaster types, and policies mostly for prevention or preparations are being planned.

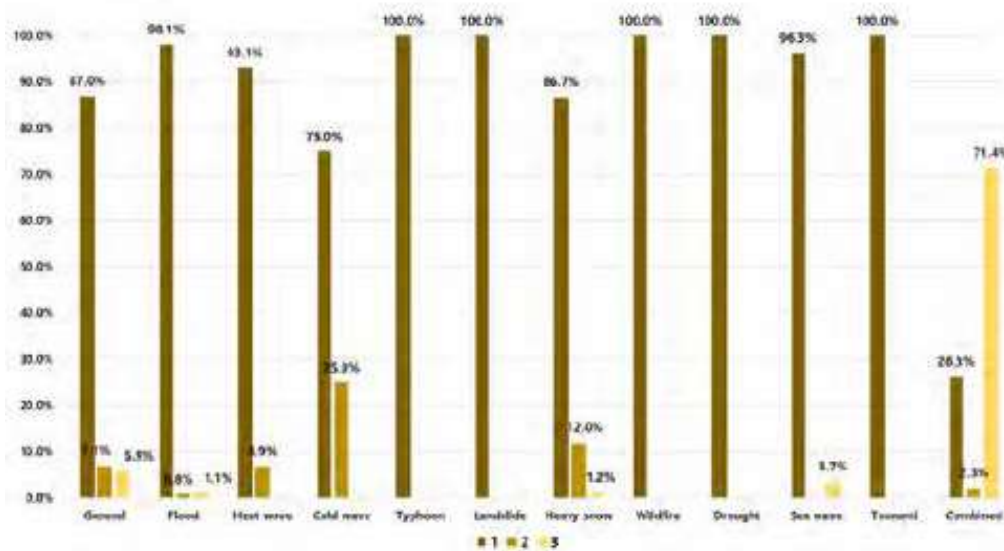


Figure 10. Content analysis of the Climate Change Adaptation Action Plan by disaster type (Implementation)

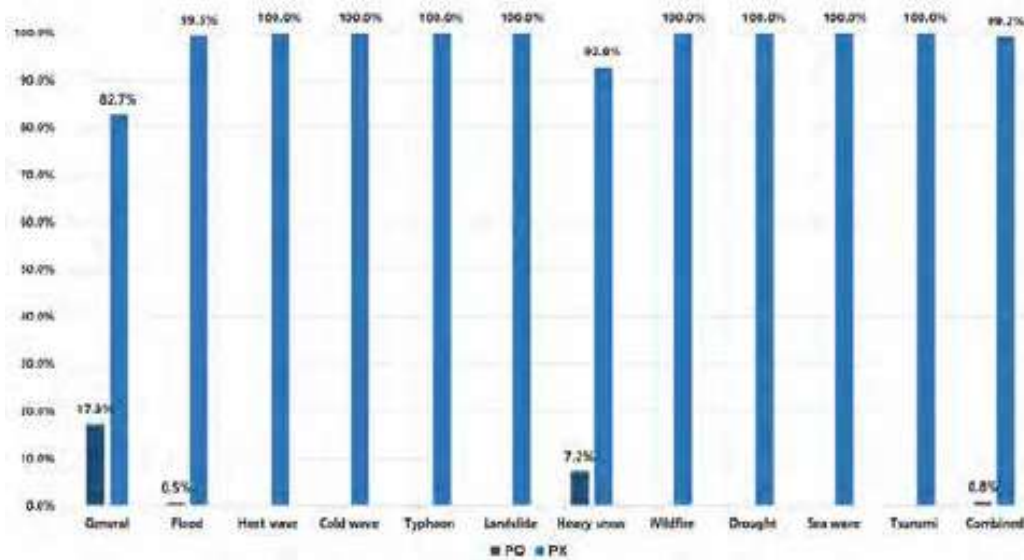


Figure 11. Content analysis of the Climate Change Adaptation Action Plan by disaster type (Participation)

Correlation analysis between disaster damage and the Climate Change Adaptation Action Plan

<Table 3> shows the results of the correlation analysis between plan contents by dimension and disaster damage. The results showed that there was a positive correlation between physical vulnerability and level of human damage, and a positive correlation between institutional vulnerability and property damage. However, the socioeconomic vulnerability had little correlation with disaster damage. There was a negative correlation between consideration of the environmental aspect and property damage, and the non-structural measure had a negative correlation with property damage and a positive correlation with human damage. Consideration of participation had a positive correlation with property damage, and there was little correlation between disaster damage and a number of plans. This result implies that regions with many property damages are concentrating on institutional vulnerability without considering the environmental aspect and tend not to adopt non-structural measures, and rather tend to adopt plans other than disaster response based on participation. Moreover, regions with many human damages mostly focus on physical vulnerability and tend to adopt non-structural measures.

Table 3. Correlation analysis table

Dimension [↵]	Variables [↵]	Economic damages [↵]	Human Injury [↵]
Fact base [↵]	Physical vulnerability [↵]	.313 [↵]	.611** [↵]
	Socioeconomic vulnerability [↵]	-.135 [↵]	-.043 [↵]
	Institutional vulnerability [↵]	.594** [↵]	-.050 [↵]
Goals [↵]	Environmental based [↵]	-.609* [↵]	.195 [↵]
	Non-environmental based [↵]	-.339 [↵]	.105 [↵]
Policies [↵]	Structural measure [↵]	.097 [↵]	.106 [↵]
	Non-structural measure [↵]	-.469* [↵]	.489* [↵]
Implementation & Participation [↵]	Before disaster [↵]	-.285 [↵]	-.354 [↵]
	During disaster [↵]	-.579** [↵]	.254 [↵]
	After disaster [↵]	.114 [↵]	.033 [↵]
	Based on participation [↵]	.445* [↵]	.055 [↵]
	Non-based on participation [↵]	-.366 [↵]	.072 [↵]
Amounts of plans [↵]		-.058 [↵]	.094 [↵]

* : p<0.1, ** : p<0.05[↵]

Discussion

The analysis by region showed that all regions were establishing the action plans without considering the environment and participation as important. Moreover, most regions were establishing plans related to physical vulnerability, as well as plans for ‘prevention’ or ‘preparations’ implemented before disaster. Yet, while there were relatively more regions

establishing plans based on structural measures, there was not much difference among the methods.

The analysis by disaster type showed that the environmental aspect was not considered as important in all disaster types except drought, and participation also was not considered as important in all disaster types. Physical vulnerability was considered important in most disaster types, but generally, cold wave, heavy snow, and wildfire considered institutional vulnerability and combined disasters considered socioeconomic vulnerability as important. While there were relatively more disaster types establishing plans based on structural measures, there was not much difference among methods. Furthermore, most disaster types were establishing plans for 'prevention' or 'preparations' implemented before disaster.

Based on the results above, this study comes up with the following implications about the tendency of the Climate Change Adaptation Action Plan in Korea. First, lower-level local governments in Korea tend to establish the Climate Change Adaptation Action Plan for before disaster without considering the environment and participation. This implies that lower-level local governments have limitations in considering the environment and participation when establishing climate change plans. Above all, this indicates that such factors are not perceived as important factors of climate change plans in the disaster sector. Furthermore, they are focusing 'climate change adaptation' in disasters on reducing disaster damages that may be caused by climate change.

Consideration of vulnerability by region varies depending on disaster vulnerability status due to climate change and regional circumstances, but it was found that physical or institutional vulnerability was considered important, while the socioeconomic vulnerability was barely considered. This implies that efforts are made actively to reduce physical or institutional vulnerability due to climate change, but socioeconomic vulnerability is considered relatively less importance. In other words, socioeconomic vulnerability does not take up many portions of disaster vulnerability in the region and is considered less important.

Similarly, climate change policies were adopting different methods depending on disaster type. For example, disasters with damages from storms and floods such as flood, typhoon, sea wave, etc. had a higher ratio of structural measures, while heavy snow had a higher ratio of non-structural measures. However, considering that the major disaster type according to climate change in most regions is damage from storm and flood, the ratio of structural measures is higher in many regions.

As a result of analyzing the correlation between disaster damage and plan contents, plans to reduce physical vulnerability had a positive correlation with human damage, and plans to reduce institutional vulnerability had a positive correlation with property damage. This implies that the action plans in Korea were using plans to reduce physical vulnerability in regions with more human damages, and plans to reduce institutional vulnerability in regions with more property damages. However, the low correlation of socioeconomic vulnerability shows that it is relatively not considered much in the plans by region.

The negative correlation between property damage and consideration of the environmental aspect indicates that regions with greater property damage were establishing plans without considering the environmental aspect. This is because regions with more property damages were more preferentially considering policies that can produce quicker damage reduction effects than long-term measures considering the environmental aspect.

Non-structural measures had a negative correlation with property damage and positive correlation with human damage. This indicates that lower-level local governments tend to more prefer adopting non-structural measures to reduce human damage, but rather tend not to prefer non-structural measures to reduce property damage.

Conclusion

The present study analyzed the Climate Change Adaptation Action Plan of lower-level local governments in Korea by region and disaster type using four dimensions. In addition, it analyzed the tendency to plan contents by analyzing the correlation between the details of each dimension and damages due to disasters. The results showed that many of the Climate Change Adaptation Plans in Korea were establishing adaptation measures that can be performed before the disaster in order to reduce physical vulnerability. There was a difference in the ratio of structural or non-structural measures depending on region and disaster type, but overall there was a balanced distribution. However, the environmental aspect and participation were not considered in most policies.

Regions with many property damages tended to establish plans based on participation in order to reduce institutional vulnerability. On the other hand, they tended to prefer policies based on methods other than non-structural measures without considering the environmental aspect, and plans to implement in stages other than during disaster. Regions with many human damages tended to prefer policies based on non-structural measures to reduce physical vulnerability.

In conclusion, the Climate Change Adaptation Plan of lower-level local governments in Korea were analyzing disaster vulnerability due to climate change faced by each region. However, there were limitations in considering aspects of the environment and participation in the contents of the plan. This indicates that most regions were not considering the environmental aspect as important in establishing disaster policies within the climate change plan. Furthermore, there is lack of consideration for participation as planning is carried out 'top-down'. This tendency may be an obstacle to improving the autonomous adaptation capacity of each local government for climate change and establishing more sustainable plans and policies.

To overcome these limitations in plan contents, the following matters can be improved. First, it is necessary to add policies to induce participation in the Climate Change Adaptation Action Plan. It is important to improve the abilities of major institutes and agencies to deal with disasters caused by climate change, but it is more essential to improve adaptation capacity and knowledge of individual citizens. This is necessary for the nation to effectively handle climate change, based on which the overall climate change adaptation capacity of the nation can be secured.

Second, the Climate Change Adaptation Action Plan must also actively consider the environmental aspect to establish sustainable climate change adaptation and reduction policies. Considering the environmental aspect in climate change adaptation and reduction measures in terms of disaster management indicates that damages can be reduced by improving the nature's and ecosystem's ability to adapt to climate change. In other words, the Climate Change Adaptation Action Plan considering the environmental aspect will improve environmental competencies in the long run, ultimately contributing to improving adaptability to disasters, and can be used as a more sustainable adaptation plan for climate change.

Third, the Climate Change Adaptation Action Plan must further add consideration of socioeconomic vulnerability. Socioeconomically vulnerable groups are more vulnerable to disasters due to climate change, and thus planning to protect them must be considered. This is the nation's duty and obligation to improve the safety of the society overall toward disasters due to climate change, and must be considered additionally in the contents of the climate change plans in the future.

Acknowledgements

This work was supported by the Yonsei University Future-leading Research Initiative of 2018 (2018-22-0096).

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