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Research on a Method of Diagnosing Building Vulnerabilities under the New International Climate Change Agenda

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Chapter 1: Introduction

For a long time, we have been preparing social, physical and institutional measures to respond to climate disasters. When a disaster occurs, people generally try to find a safe place. In urban areas, the built environment, including typical buildings, becomes the principal source of refuge as indoor spaces are expected to be safe. Climate disasters, however, frequently exceed the expectations of such measures and the limits set in the past. This means that the built environment, such as buildings and facilities, could no longer be considered a safe space.

Following the Paris Agreement of 2015, Korea signed the Paris Agreement on Climate Change on April 22, 2016 with 168 participant countries. This means that Korea needs to follow the direction of the next climate change policy set by the international community. In addition, Korea will have to set a practicable national target and an operating system for local governments.

The climate change policy needs to include separate requirements for cities and buildings. However, current Korean policies and measures for dealing with climate change do not take into consideration of buildings and the urban

environment.

The main research topics of this study are as follows: First, it identifies the characteristics of buildings that are repeatedly affected by specific natural disasters; second, after the explanatory characteristics of individual buildings are identified, this research aims to determine how buildings with similar characteristics are distributed in the surrounding area.

Chapter 2: The Trend of Climate Change Adaptation Policy and Research

As regards the climate change adaptation policy, the overall climate change vulnerability diagnosis of buildings does not show any significant difference from that of other subjects, except for differences in the types of climate change adaptation strategies to be applied to primary industries such as agriculture and fisheries.

Major overseas adaptation policies include detailed strategies in terms of increasing resilience, partnerships between governments and regions, the utilization of scientific technologies and data, and efforts to enhance community sustainability. In Korea, the risk of flooding in residential areas and coastal structures has been assessed; and climate change impact and vulnerability assessment systems for large industrial complexes have also been prepared.

Assuming that a disaster caused by climate change is an event and the (affected) buildings are a social space, social complexity and the physical, natural, and built environment are necessarily considered with the need to minimize risks and damages.

The methods of climate change vulnerability diagnosis currently applied under the domestic climate change adaptation policy use the administrative district as the spatial range. The actual impacts and effects of climate change, however, exceed the scope of the administrative area, thus limiting the effectiveness of the diagnosis results. The assessment of vulnerability, therefore, necessarily considers the minimization of the basic analysis unit, with understanding the social condition of the analysis unit. The climate change vulnerability diagnostic model for buildings needs to be designed to explain exposure, sensitivity, social response and resilience, and thereby to identify the social elements that buildings represent.

Chapter 3: Establishment of the Climate Change Vulnerability Analysis System

Spatial vulnerability diagnosis with high resolution can be accomplished not by considering the administrative district as the spatial unit but by adopting a facility, a parcel or a building where citizens actually live as the spatial reference unit. When this spatial reference unit is distributed across a certain area, it represents a climate change vulnerable area. As a result, a bottom-up approach is suitable for this type of vulnerability diagnosis.

This research takes heavy rainfall as the subject phenomenon of the climate change vulnerability diagnosis for buildings. Among the various weather phenomena caused by climate change in Korea, heavy rainfall sometimes causes many casualties including fatalities and life damages. The subject of vulnerability diagnosis applied in this study is, therefore, flooding due to heavy rainfall. Residential and non-residential buildings, where most people devote their time to residential and production activities, constitute the main spatial extent of this research. This research also focuses on buildings in damaged areas that have experienced repeated flooding due to heavy rainfall.

The basic aim of the analysis of surface water flooding of buildings is to determine the spatial distribution of buildings; it is characterized by the standardized explanatory variables of buildings in the flooded area. In the case of several buildings in a parcel, this research applies the characteristics of the main building of a parcel to that parcel in order to build an effective model for diagnosing the influence of surface water flooding on buildings.

Among the least degree of missing information in the building register, this research selected indicators applicable to climate exposure, sensitivity, and adaptive capacity, and included an explanatory indicator of building location environment and flooding. Surface water density, adjacent manhole density, and the elevation of the average sea level are also included to represent the influence of surface water flooding in urban areas. In addition, the officially assessed individual land price is included as a social indicator related to adaptation capacity.

Chapter 4: Analysis of Building Risks and Vulnerabilities

A basic database consisting of the building register, social data, and geographical data was built for the SMG(the Seoul Metropolitan Government) in order to consider explanatory information on climate change vulnerability such as climate exposure, sensitivity, and adaptation capacity.

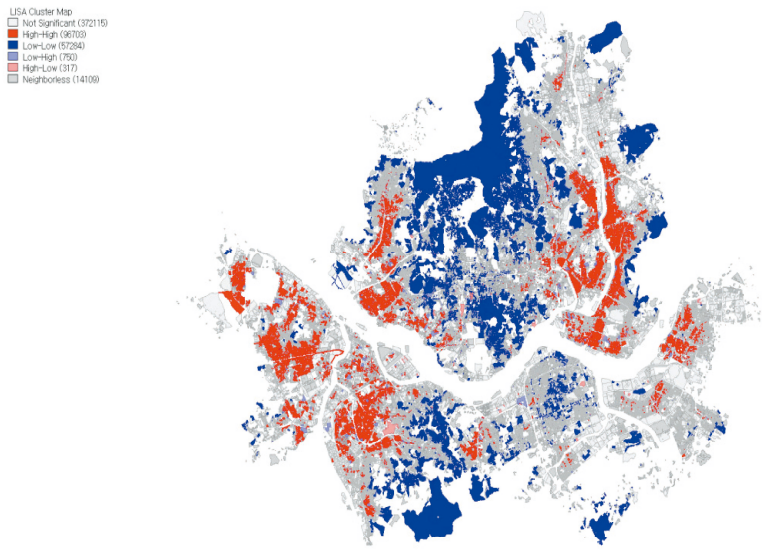
The characteristics of buildings in flooded areas affected by climate exposure are inferred through spatial regression analysis. The spatial regression model uses the OLS (Ordinary Least Square) method.

The spatial regression analysis, which is based on the relationship between building information, reveals that buildings located in Seoul with a high risk of repetitive flood damage have greater climate change vulnerability in the following cases: when the building coverage ratio is higher, the floor area ratio is lower, the number of households is larger, the number of floors is lower, the number of underground floors is larger, the period of building use is shorter, the official land price is lower, the adjacent manhole density is higher, the surface water concentration is higher, and the average sea level of the parcels is lower.

Buildings are a complex combination of physical, economic, social, institutional, and environmental factors. The type of climate change vulnerability diagnosis and assessment model used to deal with buildings, therefore, should be the social vulnerability model. This model suggests that the general public can analyze and utilize climate change vulnerability maps more easily using GIS. Since spatial information based on a certain spatial unit includes various types of socioeconomic information and its distribution can be identified, it is very useful for analyzing vulnerability by enabling spatial statistical processing through the sharing of spatial information.

Buildings in a parcel with high vulnerability should have the ability to secure resilience through their form and composition, considering the elements of climate change 'adaptation' and the minimization of 'loss and damage' by exposure. The climate change vulnerability diagnosis model of this research has an advantage in that it selects parcels of buildings vulnerable to heavy rainfall while simultaneously deriving safe parcels. Since the results of the diagnosis are based on the parcel unit and high spatial resolution, local governments could apply this model in various ways.

The vulnerability diagnosis model proposed in this research can be used in urban planning and detailed planning for climate change adaptation when the focus is on climate change vulnerability, and in low impact development projects and water circulation improvement projects for climate change prevention when the focus is on deriving safe areas.



[Figure] Vulnerable areas (red: HH) and safe areas (blue: LL) as shown by the results of LISA analysis

Keywords : Repetitive disaster risk by climate change, big data related to buildings, spatial regression modeling, climate change adaptation policy, GIS

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