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A Study on the Resilience of Urban Disaster through Space Design: Focusing on Nagasaki City, Japan

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A B S T R A C T

Historically, we could find through case studies and researches that cites are recovering themselves from disasters and accidents. Resilience refers to the power of returning a state changed due to some stimulation to its original state. The criteria suggested as the basis of the resilience of the city is based on the reconstruction of the city and it does not deal with the recovery of citizen who are the elements of the city. As modern citizen living in the city are exposed to various formal dangers, space design making a harmonious environment to recover it are getting attentions, Therefore, in this study, we paid attentions on hearing that can greatly affect vision in spatial design and assumed it as a component of the spatial environment and performed simulation of improvement effect. By identifying the effect of the objects constituting the space to the entire landscape through the analysis result, we could efficiently figure out the effect of improving the space. Also, through the results, it is judged that the rational improvement direction of the resilience space environment can be derived by using the quantified data as basic data in the resilience space plan.

Key words: urban disaster resilience, emotional resilience, resilience spaces, urban design, simulation of improvement effect

Introduction

Cities are the center of ideas, industry, culture, science, productivity, social development and more. The city itself allows people to socio-economically advanced. As the half of the population is living in these cities that are in the center of climate changes, resource exhaustion and unplanned urbanization, making sustainable and resilient city is of our greatest challenge and opportunity (Unisdr, 2017).

Cities always resile from the damage caused by natural disasters such as typhoon and earthquakes, and social disasters such as wars and various accidents. Also, it is exposed to the corporate labor dispute caused by ideologies pursued and violence of anti social personal disorder. When we examined the cities that have been resile from the past damages, we could verify the resilience of the cities. However, as resilience is biased in terms of facilities, research on resilience, social healing and emotional reconstruction on citizen that is one of the urban elements[1)] are relatively lacking.

In the cities of Korea, there has been rapid expansion in terms of material as well as rapid economic development. In order to accommodate the growing population, quantitative expansion of

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city has been continued and instead of utilizing the existing downtown, it has been expanded externally by constructing new cities nearby. As a result, the infrastructure and buildings in the city became aging and the local economy stagnated over time and it caused the city's community to be weakened and reducing the vitality of the downtown. The government is implementing various urban regeneration policies to solve the city's physical, environmental, social and economic problems. Through improving the physical environment of the city and re-creating local commercial areas, creating new industries and jobs, and improving a culture and welfare environment and vitalization of resident's participation, these policies are trying to vitalize the city (Lee, 2011: 100).

Based on the assumption that cities have resilience, this paper presented simulation method on improvement effect of spatial environment about the space that contributes to the resilience of the urban citizen by considering hearing that is regarded as an important mean together with vision among five senses that can perceive space.

Theoretical Background

Urban Resilience

The meaning of resilience in dictionary means returning to the original state or the thing that changed by external influence return to the original state after external influence disappears.

Traditionally, resilience has been used in physics and psychology. In physics, it means the ability of an object to return to its original state after being shocked while in psychology it means the ability to overcome shock or trauma and survive successfully (Barata-Salgueiro & Erkip, 2014; Choi & Seo, 2018).

By examining the cities that are presented as a basis for urban resilience, we can identify the basis of resilience. Although Chicago in the United States was largely lost to fire in 1871, the city was changed to a new city filled with high rise buildings through urban reconstructions and reborn as city with vast park which cannot be seen in the other cities. Although two thirds of the inhibitants of Sanfrancisco losted their homes due to the earthquake of 1996, it is now a global port city and attracts many tourists. Although Tangshan in Hebei Province of China suffered major earthquake damages in the 1976 resulting in more than 240,000 victims, the city was resiled through various city reconstruction projects. In addition, although Japan's Hiroshinawa Nagasaki was destroyed by the first atomic bombing in 1945, it has now developed into an international peace and culture city. In addition, although cities such as Dresiden of Germany and Koveltree of England were also heavily damaged from World War II, they are the area where resilience and restoration of historical buildings were completed simultaneously.

As such, the cities which experienced disasters have shown its own resilience. However, as a resilience case after disaster, it only address human casualties on citizen which is the one of the element of city and does not deal with survivors' injuries, illnesses and traumas.

Expansion of Resilience

The concept of resilience has been first introduced in the paper 'Resilience and Stability of Ecological Systems' by Holling(1973). It is the origin of the modern resilience theory and often mentioned (Klein, *et. al.,* 2003; Folke, 2006; Meerow & Newell, 2015; Meerow, *et. al.,* 2016; Choi & Seo, 2018).

The concept of resilience has been developed by Holling in two perspectives. First, engineering resilience is the nature of returning to the stable state of equilibrium after disturbance or destruction. Engineering resilience values the speed of return to equilibrium, and it has the characteristic of resisting against perturbation to alter the nature of the original characteristics by maintaining the effectiveness of functions and focusing on system continuity and predictable world (Pimm, 1991; Folke, 2006). On the other hand, the concept of ecological resilience refers to the ability of an ecological system to continue functioning. It is the ability to maintain and sustain its essential function without having to return to its original state even if there is a change in the ecological system (Holling, 1996: 32-36). In ecological resilience, the equilibrium point can be several rather than one, and it maintains the essential function, structure, identity and feedback without system being collapsed (Walker, *et. al.,* 2004). Through this, several scholars state that non-equilibrium resilience is a new paradigm in ecology and Holling's

1) Elements of Urban Space
① It is a citizen. Citizen is an active subject who constantly changes the urban space as a living subject of the city or subject constituting the city.
② It is activity. The people who gathered in the city decide the land use and change the land space by separating the urban space or assigning characteristics to the urban space as the urban activity between human beings for the sake of individual survival and benefit.
③ It is land. Land is a natural foothold necessary for human activity and is shaped and changed by the location and activity of the city. It is a physical element with absolute values and spatial limits.
④ It is a facility. It is element that physically shaping the urban space and serving as landscape element. Especially, urban facilities are called infrastructure, including buildings, roads, and sewerage.

various writings on resilience have led to many studies at the socio-ecological point of contact (Folke, 2006; Wu & Wu, 2013; Meerow, *et. al.,* 2016).

Design and Resilience

The city is the center of social, economic, and political activities. It is area that is densely populated with houses of thousands and tens of thousands of people and where traffic routes are concentrated and the place where people, spaces and things are harmonized together, However, the modern urban environment constructed with lack of understanding on human life and economic logic created excessive stimulation and unnecessary concentration to people (Kim, 2017: 82). In addition, modern cities generate excessive stimulation due to the information made of various senses. Particularly, attention grabbing objects such as letter, colors and lights in commercial advertisement create excessive cognitive load on the human brain. When consistently exposed to extensive stimuli created by various elements forming environment, for instance, such as card sounds, street musics, street signs, traffic signals and road patterns that are attracting people's attention with various purpose, brains that recognize these are consistently under tension. This state is defined as directed attention in attention restoration theory which studies the relation between human psychology, emotion and environment and especially, it points out that it appears frequently in city environment where elements are not well harmonized.

Human experiences a sense of stability and a resilience environment by feeling harmonious stimulus in harmonious environment. However, each stimulus element consisting of city creates disharmony and it is recognized as an excessive stimulus to human perceiving it and recognized as environment creating stress, In comparison, as the natural environment creates harmony between the elements, and these stimulus elements are recognized as a representation, it has the effect of relaxing tension in this environment.

Healing

Healing has the origin of word in Healen of Anglo-Saxon with the meaning of “Completed”. The harmony of mind, body and soul means health and the process of getting out of disease is also understood as the meaning that spirit, body and soul are completed as one (Lee, 2010; Park, *et. al.,* 2015).

In the formation of healing environment, there are important elements such as nature, society and space centered around people. As the fact that the natural environment plays an important role in the resilience of the disease has been known since ancient times, healing landscape as healing environment for physiological response of human has been emphasized in the medical facilities such as hospitals, hospices and health sanitarium (Kwon & Lee, 2019; Ji & Yang, 2007).

Forest Healing

According to the article 2, paragraph 4 of " The law on Forest culture and recreation", forest healing is defined as activity to increase the body’s immune system and health using the various elements of nature such as fragrance and landscape.

The main theories related to the psychological effects of forest are the stress reduction theory advocated by Ulrich(1983) and the theory of attention resilience advocated by Kaplan & Kaplan(1989). Ulrich(1983) has revealed through many experiments that natural environments such as vegetation and water systems become environments that cause resilience from stress. In addition, Kaplan & Kaplan(1989) mentioned that when the attention is lost, it becomes a state of attention fatigue and the natural environment such as forest is the typical environment to restore depleted attention. The basis of these two theories is focused on the psychological effects of forests (Cho, 2015; Park, 2010).

Recovery Space in Everyday Life

When we look at the definition of daily life in lexical meaning, it can be defined as thought or characteristic that are fixed in daily life. Henri Lefevre explains that everydayness defines the urban characteristics of a highly developed modern industrial society and that the apart from everydayness in modern society means losing one's social existence (Henri, 1990; Kim, 2019).

Rowles(1978) explained that it is more likely to feel the permanent feelings in the resilience space (house, parks, play areas) that have settled as daily life in someone’s life and even if the feeling can be instantaneous and temporary, it can lead to efficient healing if it can continually accumulated or lead to a series (Park, 2017: 51). In other words, when the experiences in the daily resilience space accumulate, the resilience effect can expand and this experience from resilience space can be sublimated to the story of resilience and it becomes a supplier that effectively supports the resilience experience (Park, 2014: 559).

Recovery effect through design intervention

Marcus (Marcus, 2007) stated that the resilience effect appears through the transition of atmosphere and correlation of design intervention appearing through physical environment. Ulrich (Ulrich,

1991) stated that changing the surrounding environment positively as positive attention transition (Sung, *et. al.,* 2013: 514).

Stress is a phenomenon that is perceived when people's reaction ability cannot cope with environmental stimuli. As people live and interact in the physical environment, the physical environment plays an important role in stress and coping with stress response. Through the characteristics perceived in a specific landscape, positive emotions can be felt and negative thoughts can be controlled to return to an appropriate level of emotion. Ulrich also focuses on recovering stress from the physical environment and it is stated that various non-mental fatigue one said to promote resilience from the kind of stress (Shin, 2014: 118).

Evaluation Method and Result

Evaluation Method

In this study, we selected survey sites and conducted field research. The city of Nagasaki is the place where atomic bombs were thrown during World War II and there are victims who are still suffering.

The topography of Nagasaki City is a port city surrounded by three mountains and it has a shape similar to that of Busan City in Korea. The city of Nagasaki convey the devastation of the atomic bomb today and as it has the spirit of peace appealing as the origin of peace and has been the port of the trade between Portugal and the Netherlands since the 17th century and the center of Christian mission, it still remain as a city with foreign atmosphere. It is the city full of exotic temples such as Christian churches and buildings, and it is where Mitsubishi Heavy Industries Nagasaki Shipyard is located.

Samples forming the scenery at each survey point were extracted and photographed with a video camera. After all, evaluation was performed on the objects and sounds that form the space using the video data captured. The 13 items of adjectives (herein after referred to as 'Item') are related to the impression evaluation of the object.

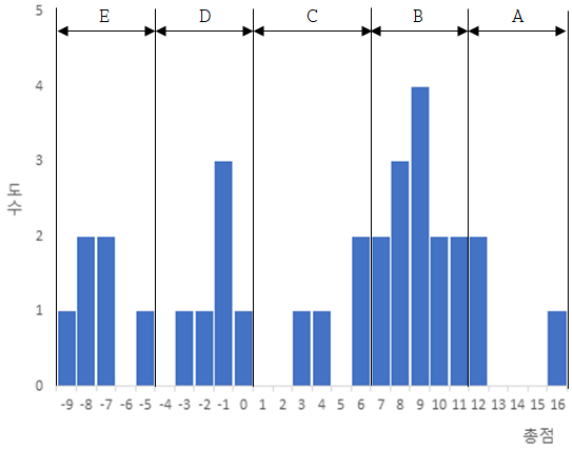
For the evaluation and analysis method performed in this study, the method for quantifying the qualitative evaluation proposed by Yim Dong-Kyun in the previous study was applied. The overall flow of the evaluation method is as follows (Yim, 2018: 119).

First, evaluators use the SD method to evaluate each subject. Quantification theory class III is applied to this evaluation result to classify the relationship between items, and to calculate the total evaluation score of the object and set the grade. Finally, by using a total score of the evaluation object to calculate the scores of the whole region, we investigated the analysis result by performing improvement effect after improving by removing the subjects with negative total evaluation scores.

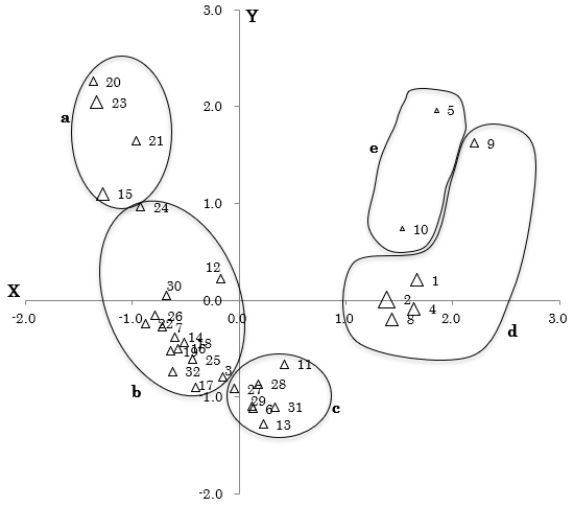
Evaluation Result

Cluster analysis was performed using sample scores obtained by applying quantification theory type III. The resulting dendrogram is shown in <Figure 1> and the distribution of each sample is shown in <Figure 2>.

As shown in <Figure 2>, the samples of group a are distributed in the right area from the center, and groups from group b to group e are distributed clockwise. Also, as samples with bad impressions are largely distributed to the left of the second axis (Y



<Figure 1> Sample score analysis dendrogram



<Figure 2> Sample distribution

axis) and samples with good impressions are largely distributed to the right side, the second axis seems to represent the degree of "Bad to Good" for each sample. On the other hand, it is thought that the first axis represents the degree of influence on the object and sound forming the space.

Next, category score was used to classify each category group. Also, the frequency distribution map of the impression evaluation total score was created. The results were shown in the <Figure 1>. From the result in <Table 2>, we could find that the natural elements such as 'Green of Park', 'Sea', 'Sound of Wave' and etc have a relatively high impression while artificial object or sound such as 'Gate type crance', 'Traffic sound' and 'Sound of Works' have relatively low feelings.

In order to examine the relation of the result of classification using sample score and evaluation grade, cross-analysis χ2 test was conducted (<Table 1>). The realized value of the test statistics was calculated to 67.09 (significant at 0.05), and as it is larger than 26.296, the value of χ2, it indicated that there is relation between classification by sample score and exposure ranking by category score. Also, when we calculate the Cramer-related co-efficient, the relationship between the two was found to be 0.72. Therefore, the result of the evaluation performed this time was valid.

<Table 1> Cross tabulation

Group \ Rank	A	B	C	D	E	Total
a	1	0	0	0	0	1
b	2	11	0	0	0	13
c	0	2	3	3	0	8
d	0	0	1	3	0	4
e	0	0	0	0	6	6
Total	3	13	4	6	6	32

<Table 2> Classification result

No.	Sample	Rank	Grop	Score	
				Before	After
15	Green of Park	A	a	16	16
17	Koyoymaru	A	b	12	12
13	The bridge of canal	A	b	12	12
20	Sea	B	b	11	11
19	Island	B	b	11	11
24	Urakami Church	B	b	10	10
30	Sound of bell	B	b	10	10
21	Beach	B	b	9	9
26	Nearby trees	B	b	9	9
18	Steam whistle	B	b	9	9
22	Slope(Green)	B	b	9	9
25	Theological college	B	c	8	8
12	Goddess Ohashi	B	b	8	8
14	Canal	B	b	8	8
23	Sound of Wave	B	b	7	7
16	Jetfoil	B	c	7	7
27	Playground equipment	C	c	6	6
29	Toilet	C	c	6	6
31	Beep	C	c	4	4
28	Ground	C	d	3	3
6	Residence	D	d	0	0
7	Mountain	D	d	-1	0
11	Voice of cicada	D	d	-1	0
2	JIB crane	D	c	-1	0
1	Gate type crance	D	c	-2	0
3	Conrainer ship	D	c	-3	0
10	Traffic sound	E	e	-5	0
5	Materials place	E	e	-7	0
4	Dock	E	e	-7	0
32	Children's voice	E	e	-8	0
9	Sound of works	E	e	-8	0
8	Factory	E	e	-9	0
Improvement effect	Before			3.97	
	After				5.65

Improvement Effect Simulation

The effect of improving the spatial environment can be predicted by using the total score.

The improvement effect was simulated by assuming that the score of the object with a negative score of the spatial environment is 0. The improvement effect of about 1.68% was expected by comparing the pre-spatial environment improvement (Before of Improvement effect: 3.97) and the post-improvement (After of Improvement effect: 5.65). A factory or material warehouse with a negative score will need a large-scale structure that is inconsistent with the surroundings, such as possible segments within a range that does not interfere with the use and function of the building. Alternatively, the space environment can be improved through a method of creating a buffer space using plants between a factory or a warehouse facility and a road, and creating a space environment image that can be harmonized with the surrounding area.

By making signs and guide signs recognized on adjacent roads while limiting it not to dominate the spatial environment, minimizing the use of temporary guide signs such as banners and limiting the period of using, it is expected to contribute to prevent damage to the space environment through aging. As such, we can identify the effect of each object constituting the landscape of the entire

space through the simulation of the effect of improving the spatial environment. Also, through this, it would be possible to derive the improvement direction by using the quantified data as basic data in the improvement project.

Conclusion

In this paper, for the creation of space to resile the mind and body of a human being by using space design among urban disaster resilience, we examined spatial environment improvement by performing simulation of spatial environment improvement effect on the typical space having the characteristics of Nagasaki city which was the victim of the atomic bomb in World War II.

In order to create a resilient city, it is important to create more human elements in the urban space that have more focused on functional spaces. Although cities in the early stages of public design focuses on order, comfort and aesthetics, but if the resilience of city is planned in essential matters, it is required to create the resilience design containing contents beyond external change and resilience spaces with various caring contents that can resile even the trauma (Woo, 2010: 214).

Trauma which means mental injury affects the past's shocking experiences to the present is mental injury that those who face social disaster such as war and terrorism or natural disaster such as typhoon and earthquake either directly or indirectly being affected. The space that deals with trauma is “emotional resilience” among urban disaster resilience. In order to emotionally reconstruct the city damaged by disaster, the space that deals with trauma should be approached simultaneously in terms of hardware content and software content.

In this study, through the improvement effect simulation, we could find out the effect of each object constituting the spatial environment on the entire spatial environment.

In addition, in order to design a space to help the resilience, a space related to nature (water space, garden, forest, road) can be introduced to create a resilience atmosphere. In this study, simulation of the improvement effect on this space is performed. Through the results, it is judged that the rational improvement direction of the resilience space environment can be derived by using the quantified data as basic data in the resilience space plan.

In this study, through the simulation method of the effect of improving the spatial environment, we could efficiently find out the effect of improving the landscape of the entire region. Based on these results, in order for the space design improvement project to be a means for improving the useful regional image, it is necessary to express the unique nature, history and culture of the region, and maintain a good spatial environment in close relationship with the lives of local residents.

Also, by finding and characterizing the characteristics of humanities and ecological spaces such as history and culture, it is necessary to ensure that each region's spatial environment has its own characteristics and diversity and we need to try to make a resilience space where local residents can enjoy beautiful and pleasant spaces.

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