Adapting and Communicating Urban Climate by Design

‘Research through designing’ for improving current urban climate adaptation situation of South Korea

Yesol Park

Yesol Park
Registration number: 890426641130
yesol.park@gmail.com

Chair Group Landscape Architecture
phone: +31 317 484 056
fax: +31 317 482 166
e-mail: office.lar@wur.nl
www.lar.wur.nl

Postal address
Postbus 47
6700 AA Wageningen
The Netherlands

Master Thesis Landscape Architecture
Wageningen University
Yesol Park

Supervisor:
Dr. Dipl. Ing. Sanda Lenzholzer
Assistant Professor Landscape Architecture
Wageningen University

……

Examiner:
Prof. Dr. Ir. Adri van den Brink
Chair Landscape Architecture
Wageningen University

……

Second Examiner:
Ir. MA Rudi van Etteger
Assistant Professor Landscape Architecture
Wageningen University

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Preface

This thesis has broadened my overall perspective of ‘research’ and ‘design’. It particularly provided me with in-depth knowledge on the climate adaptation in urban planning and design.

The process of this thesis was entirely a meaningful learning process to me. I would like to particularly thank my supervisor Sanda for guiding me from the very beginning till the end of the thesis. Thanks to her patience, criticism, and professional knowledge, I was able to be encouraged and motivated whenever I faced barriers during the study. I believe the most important thing that I have learned from her and the thesis process is to build up a strong argumentation based on the study results derived from what I found. I would also like to thank Rudi van Etteger for his valuable advices for enhancing my design and arguments.

During my study time, I also received special help from Prof. Jusuk Koh and Anemone Beck-Koh. From their realistic, critical, and deeply considerable advices, I was able to realize that researching and designing (and maybe even life) is a process of constant self-asking, doubting, and improving.

Last but not least, I address to my family and friends who always advised me wisely for continuing on the right track. Particularly to my parents, if it were not for your understanding and external supporting, I could not finish this thesis.

Thank you to you all.

Yesol Park, 2015

Abstract

This master thesis elaborates on how landscape architects can contribute to not only adjusting urban climates, but also communicate issues regarding urban climate adaptation to inhabitants.

With rapid urbanization, combined with industrialization, South Korea is experiencing extreme and exceptional heat waves, particularly in the urban area. There is compelling evidence that this phenomenon will rise sharply in the near future.

The research aims to understand to what extent South Korean people groups – citizens, politicians, planners, designers and urban climate experts – are aware of the urgency of adapting to this phenomenon, and how far they are prepared to implement efficient adaptation measures.

From a landscape architect's point of view, the study argues that there are two potential implications for design. First, there is a need to improve the urban thermal environment; second, it is necessary to bring people's perceptions and actions vis-à-vis adapting to urban climate up to date.

In order to test and prove these arguments, an example of a design proposal has been created considering the context of a specific project site in Seoul. Focusing on the double aspects of 'functional' and 'revelatory' climate adaptation design, this proposal aims to set an example of possible adaptation practices.

The effects of the design are explained through visual impressions of the space and devices used, as well as of the potential climate improvements visitors to the site might experience.

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Problem Introduction

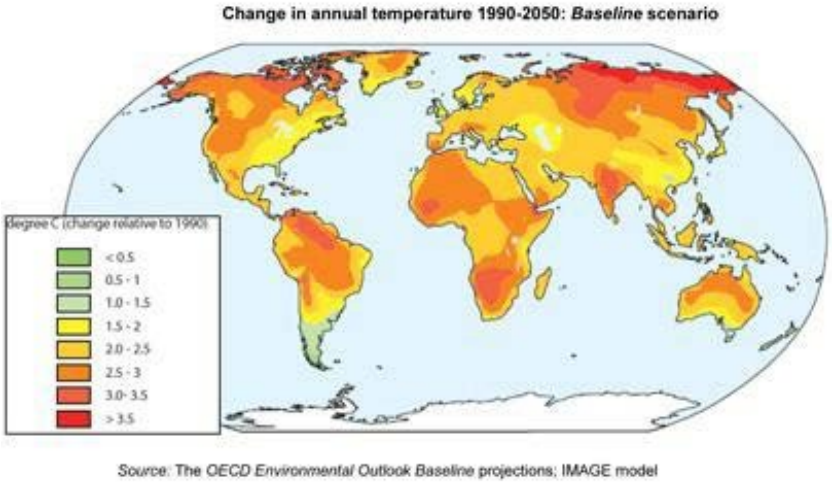


Fig.1.1 Change in annual temperature 1990-2050: Baseline scenario

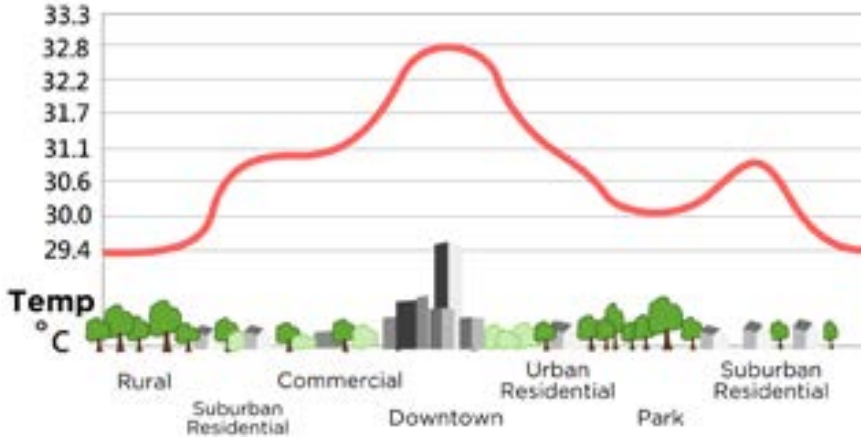


Fig.1.2 Urban Heat (UHI) Island Effect
source from: http://upload.wikimedia.org/wikipedia/commons/7/7d/Urban_heat_island_(Celsius).png

1.1. Problem statement

For the first time in history, more than half of the world population lives in cities. It is estimated that urban areas gain an average of 67 million people annually. With this increase, around 60% of the global population will live in urban areas by 2030 and approximately 6.3 billion people will live in cities by 2050 (UN, 2014).

Characteristics of rapid urbanization include population growth, land-use/ land-cover change, and intensive material and energy use (Jo et al., 2009). As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation. These factors are causing global and regional climate change. Cities throughout the world are now experiencing a new weather and climatic patterns (IPCC, 2007), in most cases becoming warmer.

The outdoor environment is deteriorating in many cities due to the growth of urban heat islands (UHI) effect, the phenomenon whereby urban regions experience elevated temperatures compared to their outlying rural surroundings (Grimmond, 2006).

This difference in temperatures leads to a number of problems related to health and well-being of humans and also negatively affects social and commercial outdoor activities. Therefore the creation of thermally comfortable climates in urban environments is obviously urgent and crucial issue that many cities of the current generation are facing.

In the past few years, some cities have started to adapt their cities to urban climate problems, however, other cities have not reacted on yet - although the problems might be considerable. The question is; Why is that? In Wageningen University, the topic of 'Urban Climate Adaptation' is one of the major research focuses. Currently the Landscape Architecture and planning group has formed an international research team to explore the reasons behind the climate adaptation differences among other continents and countries.

1.2. Study motivation

During the study in the master Atelier course of Wageningen University, I found out an impressive fact that some of European cities have get actively prepared for adopting urban climate change in planning process. Surprisingly, German city Stuttgart, has included climatic concerns in their city planning since 1938 (Hebbert & Webb, 2012). After studying on some cases of European cities, as I am a student researcher who has Korean background, I wondered how cities in South Korea are aware of urban climate issues, and what their capacity to implement adaptation strategies is. This made me be eager to look deeper into individual case studies on South Korean cities which also contribute to taking part in the Wageningen global research team.

1.3. Megacities in Asia region

According to Oxford dictionaries, 'megacity' is defined as a very large city, typically one with a population of over 10 million people (Oxford Dictionaries, 2014). The modern megacity may have been largely an invention of the West, but it's increasingly to be found largely in the East. As of 2015, there are 36 megacities in existence, and the top seven largest megacities are located in Asia. (Kotkin & Cox, 2013) From UN's projections, Asia alone will have at least 28 megacities by 2025 (UN, 2014). Seoul, the capital city of South Korea, is recently ranked the third largest megacity in the entire world (refer Fig. 1.3). Many of other major cities in South Korea also have been experiencing dramatic and fast expansion.

Rank	Megacity	Country	Continent	Population
1	Tokyo	Japan	Asia	37,900,000
2	Delhi	India	Asia	26,500,000
3	Seoul	South Korea	Asia	26,100,000
4	Shanghai	China	Asia	25,400,000
5	Mumbai	India	Asia	23,920,000
6	Mexico City	Mexico	North America	22,200,000
7	Beijing	China	Asia	21,650,000
8	Lagos	Nigeria	Africa	21,000,000[5]
9	Sao Paulo	Brazil	South America	21,390,000
10	Jakarta	Indonesia	Asia	20,500,000
11	New York City	United States	North America	20,300,000
12	Karachi	Pakistan	Asia	20,290,000
13	Osaka	Japan	Asia	20,250,000
14	Manila	Philippines	Asia	20,040,000
15	Cairo	Egypt	Africa	18,810,000
16	Dhaka	Bangladesh	Asia	18,250,000
17	Los Angeles	United States	North America	17,900,000
18	Moscow	Russia	Europe	16,900,000
19	Buenos Aires	Argentina	South America	16,500,000
20	Kolkata	India	Asia	16,200,000
21	London	United Kingdom	Europe	15,800,000
22	Bangkok	Thailand	Asia	15,350,000
23	Istanbul	Turkey	Europe/Asia	14,800,000
24	Rio de Janeiro	Brazil	South America	14,500,000

Fig.1.3 Population tables and lists of world's largest cities
source from: http://en.wikipedia.org/wiki/Megacity

1.4. Urban Climate change and adaptation issues in South Korean cities

Almost all cities over the world have a distinct urban heat island, however there is compelling evidence that most of major cities in Asian countries with rapid urban expansion experience strongly negative effects of UHI.

Urbanization combined with rapid industrialization in cities in South Korea resulted into massive infrastructure built-up and dense settlements over the past 50 years. As a consequence, cities in South Korea are intensifying heat waves because traffic, buildings, and sparse vegetation all increase temperatures further. (Kysely, J. & Kim, J., 2009).

Increasing trends in average temperature and temperature extremes have been observed by many researches over recent decades. Mean temperature in South Korea has increased by about 1.5°C during the 20th century. The warming rates in Korea are much greater than the global warming trends, by a factor of 3 to 4. (Choi et al, 2007).

In 1994, Korea experienced extreme heat waves which was exceptional in terms of mortality impacts. Most summers, UHI effects are found to be associated with enhanced mortality. However, the heat wave occurred in July and August 1994, was clearly exceptional, with the total death toll exceeding 3000 in South Korea. The very large death toll ranks the 1994 heat wave over East Asia as among the worst weather-related disasters in this region. (Kysely, J. & Kim, J., 2009).

Under a more realistic assumption of gradual warming related to global climate change, the recurrence probability of an event analogous to the 1994 heat wave is sharply rising for near-future time horizons. This highlights the need for further efforts and better preparation for the risks associated with such extreme weather occurrences in South Korea.

Temperature increment and increased days over 75th percentile temperature of current summertime (June through September) due to climate change.

City	RCP[a] 4.5						RCP 8.5					
	2041–2070			2071–2100			2041–2070			2071–2100		
	Temperature increment (°C)		Added days[d]	Temperature increment (°C)		Added days	Temperature increment (°C)		Added days	Temperature increment (°C)		Added day
	Shifted[b]	Added[c]		Shifted	Added		Shifted	Added		Shifted	Added	
Seoul	2.0	0.8	35	2.6	1.2	54	3.2	1.3	62	5.5	2.9	88

CP, representative concentration pathway.
Shifted" indicates increase in averaged daily mean temperature of upper 25% of future summertime compared with present-day.
Added" indicates average of increased temperature over the 75th percentile of present summertime for increased days in the future.
dded days over 75th percentile of present summertime temperature.

Fig.1.4 Prediction of temperature increase in Seoul due to climate change (Kim, Y. et al., 2014)

1.5. Knowledge gap

1.5.1. Global Knowledge gap

There is an increase in the numbers of individual researches on planning and design strategies with regard to climate change adaptation. However, studies with reflective and comparative approach at global scale on current adaptation capacity among different countries and cities have not been conducted. Although there are some arguments that the impact of the UHI on entire global climate change is not significant (Houghton et al. 2001), understanding comprehensive global trends on climate adaptation in urban planning is a worthy of study. Collaborating with other Wageningen student researchers from different countries, this research will help close the gap in global scale comparative knowledge.

1.5.2. Knowledge gap in South Korea

The government of South Korea has moved in recent years to undertake comprehensive scientific and policy reviews, and has developed a national strategic response to climate change. Nevertheless, implementing urban climate change adaptation remains at a very early stage yet, with few concrete measures on the ground (Jo et al. 2009). In South Korea, most research attention continues to be devoted to assessing the effects of climate change, including issues of data collection, modeling and future climate forecasting. However, climate adaptation as a specific domain of research effort has rarely been focused and so far not been very satisfactory.

A few major Korean cities have started to make an effort to generate climatic information (Kim et al., 2014), but this needs to be downscaled to the regional or more specific micro level (households, communities, local government) to provide insight for adaptation strategies. Moreover, it was interestingly observed that the degree of planning interests and capacity of urban climate adaptation varies with cities, but causes of this difference have not been clearly established. The research will aim to fill this lack of knowledge.

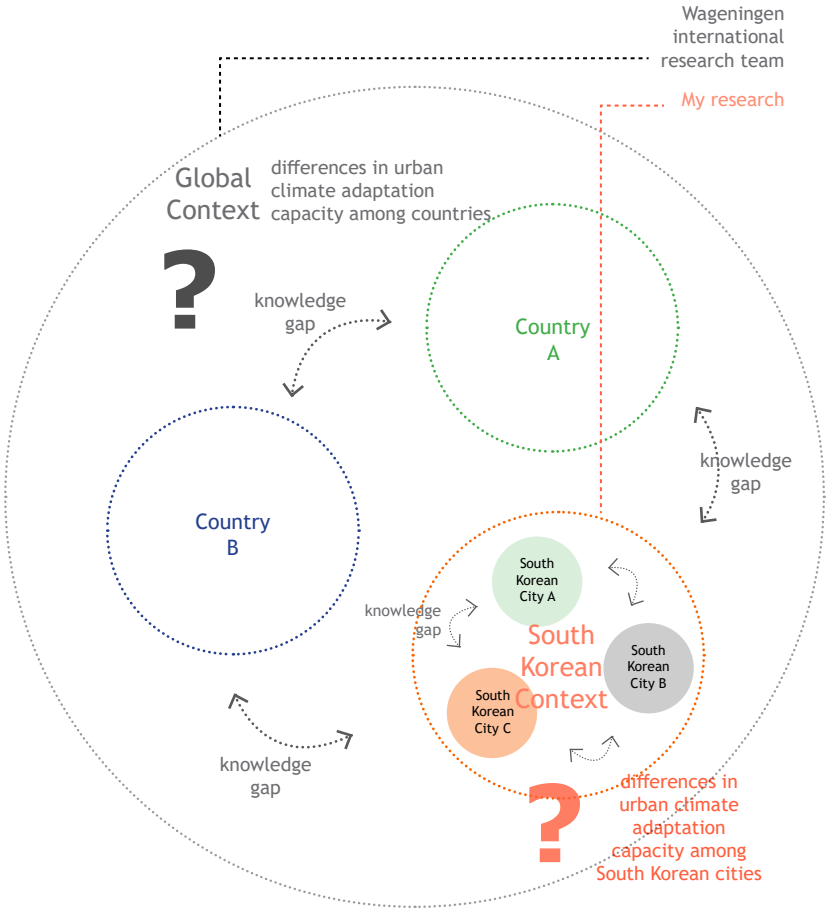


Fig.1.5 Research context and knowledge gap

Chapter 2

Research framework

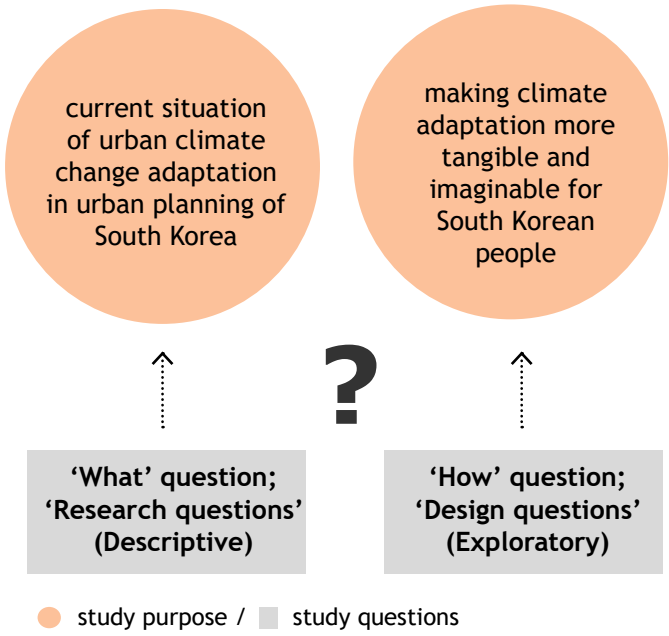


Fig.2.1 Purpose of study & appropriate question types

2.1. Purpose and objectives

Based on the recognition of problems and knowledge gaps introduced in Chapter 1, two study purposes are established. They are first of all to reflect on the current situation of urban climate change adaptation in urban planning of South Korea, and secondly to suggest implementable climate responsive landscape designs.

Considering these purposes, the objective of the research aims to identify the current situation of urban climate change adaptation in urban planning and design process in South Korea.

To achieve these purposes and objectives, this study starts with asking questions. Asking right questions is as significant as finding right solutions. Appropriate types of questions should be asked to be answered depending on the objectives of study.

For first purpose, ***1.) reflection on the current situation of urban climate change adaptation in urban planning of South Korea***, 'Research' related questions should be asked.

For second purpose, ***2.) making climate adaptation more tangible and imaginable for South Korean people***. 'Design' related questions should be asked.

Formulation of research and design questions are elaborated as follows:

2.2. Research Questions

Main research question: **What is the current situation of urban climate adaptation in urban planning and design processes in South Korea?**

Sub research questions:

Awareness and basic knowledge

- What is the sense of urgency to adapt the urban environment to climate change in your city in the future, amongst citizens, politicians, planners, designers and urban climate experts?
- In case the sense of urgency is too low, what is needed to make all the actors mentioned above feel more urgent about adapting the urban environment?

- How aware are the people involved in planning and design processes of urban climate phenomena?
- How aware are citizens, politicians, planners and designers of urban climate phenomena?
- In case awareness is low, what is needed to make all the actors mentioned above more aware of urban climate phenomena?

- How aware are the people involved in planning and design processes of urban climate adaptation measures?
- How aware are citizens, politicians, planners and designers of urban climate adaptation measures?
- In case awareness is low, what is needed to make all the actors mentioned above more aware of urban climate adaptation measures?

Planning and design processes for implementation

- Which urban climate adaptation strategies are used in the planning and design process and how successful are these strategies?
- What is the role of communication in the process of planning, designing and implementing urban climate adaptation measures?
- Which planning instruments are used to implement urban climate adaptation measures?

- Which concrete urban climate adaptation measures or interventions are used in urban climate adaptation strategies?

2.3. Design Questions

Main design question: **How can an exemplary design make climate adaptation more tangible and imaginable for South Korean people?**

Sub design question:

- In what way can the design respond to the ‘functional’ issues of urban climate adaptation?

- In what way can the design respond to the ‘revelatory’ issues of urban climate adaptation?

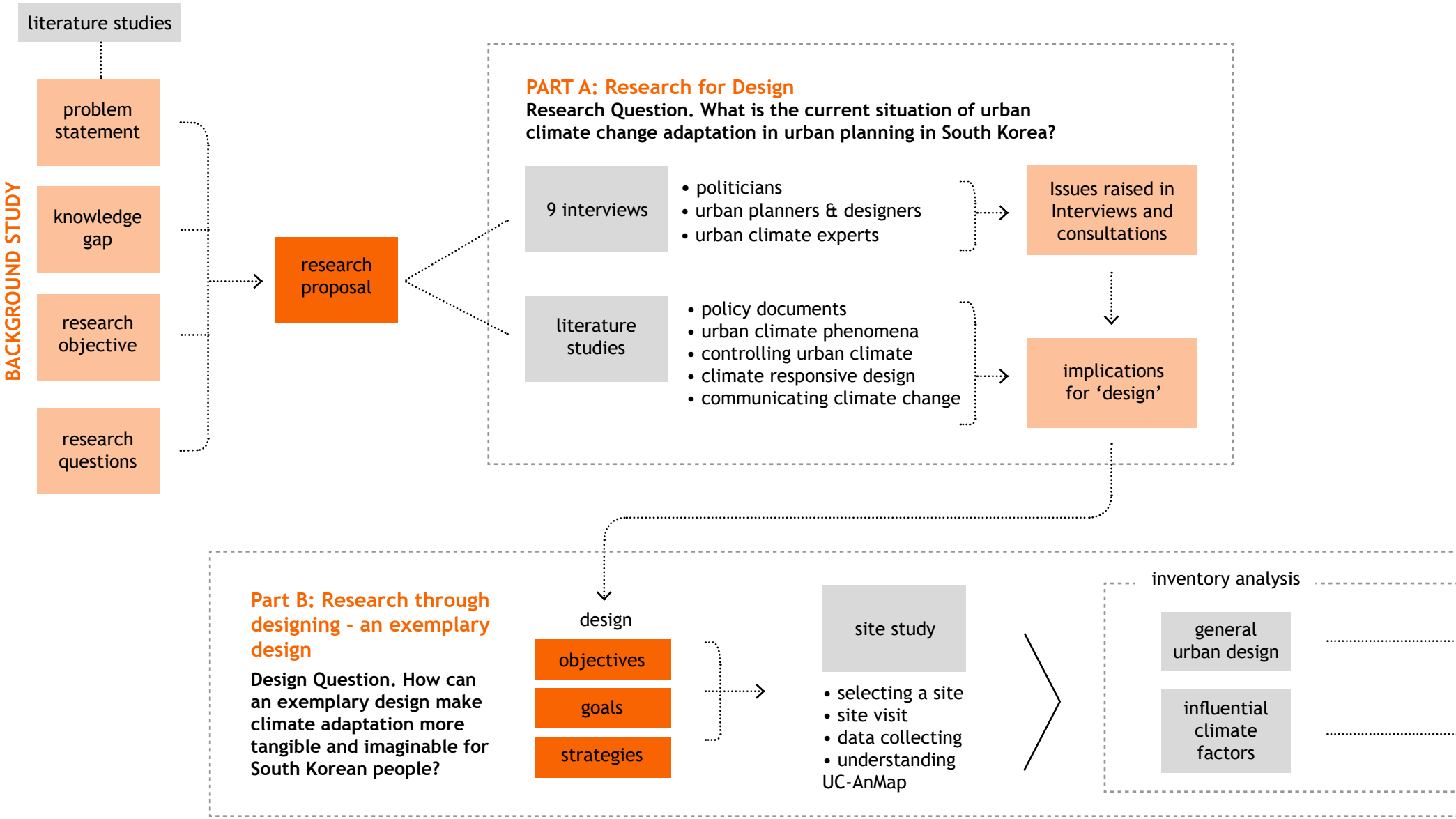
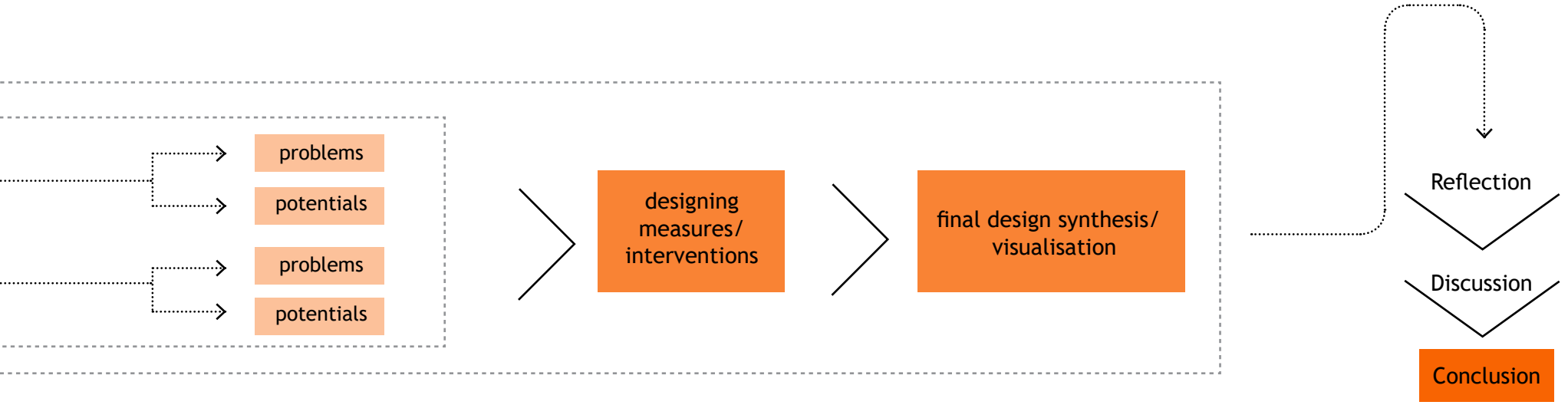


Fig.2.2 Flow chart: process of research and design

2.4. Process of Study

This study is concerned with a mixed methods approach, in which qualitative and quantitative research are being combined. Urban human settlements environment is a compound ecosystem, its factors have pluralism characteristics. Climate is one of the physical geography which has the closest interaction with human and nature environment. (Li, X. & Liu, J., 2003) Therefore, the grounds for the need of integrating multiple research methods is related to the complexity in the nature of urban climate adaptation research as well as multidisciplinary characteristic of landscape architecture.



2.5. Research for Design, Research through Design

2.5.1. Research and Design

The necessity to use designing in research processes to generate new knowledge has been stressed in landscape architecture design academia (Lenzholzer et al, 2013; Duchhart, 2011). Since 'designing' is considered as the core activity in landscape architecture's community of practice, discipline specific research methods will include combination of research and design(ing) (Lenzholzer et al, 2013). Therefore, considering the relations between design and research in this study will help to answer the study questions in a systemic and efficient way.

As shown in Fig.2.2 Flow chart, two different study stages (Part A and Part B), are proposed in regard to the types of main questions. Depending on the study stages, the relationships between design and research are also defined differently.

In Part A, their relationship can be called ***'research for design'***. In here, research activities are conducted with the aim of preparing and proposing the next step of design. Data and principles collected from research offer knowledge to ensure the functionality and appropriateness of the design. For example, outcomes from interviews and literature studies will provide certain significant lessons for Korean cities related to urban climate adaptation issues.

In Part B, the designing activity is employed as a research method, thus their interaction is called ***'research through designing'***. In this kind of relationship, designing is a process to generate, test and prove new knowledge (Lenzholzer et al, 2013; Duchhart, 2011).

To summarize, In Part A, 'research' is a main performance which generates principles and builds hypothesis. In Part B, 'design' is a main performance which tests and evaluates the hypothesis built through research and analyzing activities. Appropriate performances of 'research' and 'design' help to improve reliability and validity of the study.

2.5.2. Knowledge claims

Landscape Architecture is a discipline that deals with applicable practical science. Therefore, landscape researches, design strategies and methods ask 'how' questions. In order to answer this 'how' question, different types of knowledge are claimed per the questions and stages in the study. In the academic article, 'Research through designing' in landscape architecture (Lenzholzer et al., 2013), classifications of methods for landscape architecture research are discussed linked to Creswell's (2009) framework for knowledge claims.

According to Creswell's (2009) categorizations, the study that I will conduct tends to have characteristics of 'pragmatic research trough design'. In this type of research, both objective and subjective knowledge are claimed (refer. Fig.2.3). Positivist technical knowledge and creative methods will be combined to generate design solutions. Knowledge from socio-political aspects (constructive) has to be considered too in parallel (Lenzholzer et al., 2013; Creswell, 2009). This combination of different types of knowledge won't be mixed randomly but will set up by strategic reasoning dependent on each sequences of research through design process (Creswell, 2009).

- Positivism

type of data:
Scientific, quantitative data, include possible factors and natural elements that have an impact on urban climate and UHI effect.

collecting methods:
literature review, consulting from experts.

- Constructivisim

type of data:
Descriptive data includes current situation of urban climate adaptation and implementation in South Korea

collecting methods:
Interview, talking with people, observations, exploratory walks, photo analysis and mapping

Fig.2.3 Knowledge claims in this study

2.6. Methods

2.6.1. Literature review

Appropriate literature reviews for different knowledge claims will help to prove trust, worthiness, authenticity, and validity of the study.

As one of the major research methods, literature reviews will be taken in two stages within this study for different aims. First of all, before suggesting a concrete study proposal, primary reviews on some literatures help to get starting position of study. Through reviewing literatures at background study stage, problems and knowledge gaps are defined, thus research objectives and questions are also derived too.

The desk study in Part A requires more amounts of and various types of literature reviews. Landscape architecture is well positioned to improve the negative effects of urban climate change through planning and site design, but only if the designer understands how an urban environment creates microclimates. The researcher, therefore, should be able to accumulate and summarize climate knowledge at the appropriate scales since this information will be used to analyze a study site and identify climate-related problems. (Lenzholzer. & Brown., 2013).

For these reasons, reviewing literatures under the theme of following keywords; policy documents, urban climate phenomena, controlling urban climate, climate responsive design, case study, are suggested to build the ground of knowledge and data set.

2.6.2. Interview

In this study, interviews play a key role as the main method for qualitative research. Because resources from literature studies are limited, taking interviews was used as an alternative method. Moreover, more realistic opinions on current urban climate adaptation are gathered in light of actual situation in South Korean cities.

In total, 9 interviews will be conducted with people who are working closely related to this topic. In order to get valuable and relative information, the variety of 9 interviewees (including politicians, urban climate experts, urban planners and designers) will be carefully considered and selected. Reviewing on literatures and web articles with the topic of urban climate adaption of South Korea helps to find potential interviewees.

Chapter 3

Part A: Research for design

3.1. Introduction to the 'Interview'

As in the international global research team, this study sought to obtain local expert feedback on the urban climate adaptation in South Korean planning and design agenda while collecting data for the study. For this, exploratory in-depth interviews were conducted with representatives of nine interviewees in a variety of related fields and practices (i.e. government officials, climate (technical/scientific) experts, urban designers, and landscape architects). Information of nine interviewees are shown in Fig. 3.1.

In preparation, a questionnaire for in-depth interviews was formulated by the international Wageningen research team to guide and structure the form of the interviews (Refer to Appendix 1).

Participants from three Korean cities (Seoul, Suwon, Daegue) were selected for their involvement in climate adaptation at different stages of the planning and design process, knowledge of local climate risks and challenges, and familiarity with policy and planning action for climate adaptation in their cities. On average, each interview lasted one hour. In addition to the interviews, it was possible to get written policy documents or reports related to climate adaptation in each city. These sources helped to review on the discussions, and to ensure the accuracy of understanding on the information and data after the interviews.

Government officials	Urban planners & designers	Urban climate experts
Director of Climate Change & Sustainability Department, Seoul Metropolitan City Government, Yongsoo Choi	Landscape Architect, Office PARKKIM, Yoonjin Park & Jungyoon Kim,	Climate Expert, Noa Solution, Consulting Company for Disaster Preventing System, Woobae Sim
Manager of Urban Climate Municipality, Suwon City Government, Eunjung Park	Urban Designer/ Architect, Kcal architecture Chul Kong	Climate Researcher Research Institute for Climate Change Response, Kiho Kim
Manager of Territorial Planning Department, Daegu Metropolitan City Government, Hunsik Bae,	Policy Researcher, Korea Research Institute for Human Settlements, (KRIHS Policy), Kwangik Wang,	Professor, Keimyung University, Daegu Faculty of Built Environment, Kim Haedong,

Fig.3.1 Information of nine interviewees

3.2. Lessons from the interview results and discussion on the implications for the 'designing' disciplines

In this chapter, the results of the semi-structured, in-depth interviews will be summarized following the order of the interview questions under the four main themes of 1.) Awareness, 2.) Communication, 3.) Instruments, and 4.) Implementation. Key lessons will be concluded at the end of each part, then they will be also discussed from the point of view what a designer/ a design can do.

3.2.1. Awareness

Q 1. What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?

Most of the informants agreed with that the sense of urgency about climate change is quite high amongst all groups of people and all three study cities. There is an official research record on the extent of awareness among South Korean people. According to this record, more than 86% of citizens answered that they know global and local climate change, 59.8% of citizens have recognized the need to adapt the urban environment to that, and 40.4% of people responded that they have knowledge on adaptation measures.
An interesting point from the interview results is that the informants have differences of opinion in the sense of urgency depending on their job positions but not the cities. People from government officials and politicians showed their belief in the high awareness of people. However, planners and urban landscape designers expressed their doubts. They think the actual sense of the urgency in reality is not as high as the official records.

Q 2. In case the sense of urgency is low, what is needed to make those groups feel more urgent about adapting the urban environment?

The majority of interviewees agreed that 'education' is the most powerful measure for raising the awareness. Education programs are not always conducted in schools. Non-formal education programs through media, networking and partnerships are also essential to raise public awareness. Seoul and Suwon have active plans for increasing the sense of urgency in climate adaptation and Suwon has offered various types of education events and programmes for citizens such as the Ecomobility festival. But the Daegu municipality has less experience in providing education. International climate conferences are pointed out by several government officials as a means to promote public and political leaders' awareness. The interview results show that educations offered by South Korean cities are mostly about general climate change but the education is not sufficiently offered in providing information and knowledge of specific adaptation measures.

Q 3. How aware are the groups of the following two urban climate phenomena?

- Urban Heat Island effect

Because the majority of cities in South Korea experience great warming effects due to urbanization, they have clearly recognized the phenomenon of UHI and its impacts. In 1994, Korea experienced extreme heat waves, and exceptional mortality occurred in South Korean cities. After this extreme experience of a heat wave, Seoul started to prepare disaster prevention measures for heat waves. There is great research interests related to UHI in Korea, such as spatial vulnerability analyses

of urban populations during extreme heat events. Researches for developing measures for preventing UHI are also actively conducted by some universities.

- **Wind discomfort**

The results indicate that people are less aware of wind discomfort than UHI as a significant urban climatic phenomenon. Only one interviewee from Seoul government explained that the matter of wind discomfort in Seoul is considerable because of the high dense skyscrapers. But this interest is also limited in the experts groups. Citizens are not much aware and interested in this issue. The interviewee mentioned that the reason is because people have perception that they do not need to suffer for long from wind discomfort compare to UHI, its possible long-term risks have been often underestimated by public and mass-media. The Korean government has a big interest in developing wind corridors for ventilating air and reducing air pollution, but improving wind discomfort is rarely addressed in urban future development strategies. Thus wind discomfort seems not to be a real problem in Korea.

Q 4. In case awareness is low, what is needed to increase the awareness among those groups of two urban climate phenomena mentioned in question 3?

There was no big difference between the measures for raising awareness of urban climate phenomena and for raising the sense of urgency. Again, education opportunity was the most frequently addressed measure by interviewees.

Q 5. How aware are the groups of following four urban climate adaptation measures?

- **Urban vegetation**

Urban vegetation is the most recognized measure and the most common one in use in Korea. But this seems not to have been provided from the perspective of cooling city temperatures. In recent days, the recognition of its cooling effects is rapidly growing among local governments and planners. Suwon has a particular interest in increasing the numbers of green roofs and land for agriculture in the city. In Daegu, special emphasis has been attached to implementing green roofs on existing buildings. Financial constraints seem to be the barrier for implementation. But this has been improved by governments support. For example, Daegu city government supports building green roofs on the commercial buildings. The maximum percentage for support is 50~80% of building cost for green roofs until 2018. However, South Korea should be careful on the investment strategies for green roofs. Nowadays, people generally see green roofs as the effective solution to the urban the urban heat problem. Contrary to this, only intensive green roofs can contribute to cooling but extensive roofs such as sedum roofs often do not have cooling effect through evaporation. Moreover, the cooling effect mostly concerns the area above the roofs, so it is not very effective to people's everyday thermal environment that is situated in the streets (P.162, Lenzholzer, 2015).

- **City design**

In South Korea, planners and designers have started to become aware that city design can be a strong measure for climate adaptation. However, there are only very few people who actually have worked on implementing adaptation measures in practice. This implies the good

awareness does not necessarily convert to proactive environmental actions.

- **Use of materials**

An urban designer from Seoul addressed asphalt as the most dominant and problematic pavement material used in the city. Seoul is the city taken over by large amounts of cars, and traffic roads with multiple lanes are the major infrastructure across the city. Therefore using asphalt has huge impact on the city. However it does not seem that any concrete plans have been considered to investigate the potential benefits of using cool pavement materials. Daegu city government seems to pay more attention to implement building materials for cooling urban heat down. But it is just at the beginning stage with weak support of planning regulations.

- **Anthropogenic heat**

Anthropogenic heat is perhaps the most familiar measure for citizens. Whereas other listed measures require more professional knowledge to use and implement, anthropogenic heat is more about the behaviour which they can actually practice in their daily lives (though this measure is not so effective in terms of adapting urban climate change.). For planners and designers anthropogenic heat is the measure that they obviously have less in hand.

Q 6. In case awareness is low, what is needed to increase the awareness among those groups of four urban climate adaptation measures mentioned in question 5?

Climate educations provided by South Korean cities are lacking in offering information for adaptation measures. Appropriate types of education are required depending on the types of target groups. For urban planners and designers, high level education such as seminars or training courses are required to support them to have professional level knowledge on using measures, thus they could apply what they have learned into real planning and design projects. More importantly, 'climate aware commissioning of projects' is significantly required in South Korea. Landscape architects, office PARKKIM pointed out that very little climate aware project opportunities such as design competition have been offered to designers. If the governments release more commissions of project that have to be explicitly climate responsive, it can be very strong measure to promote designers participations. Therefore professions' and public interests both can grow effectively through more explicitly climate responsive design projects.

Moreover, the increase of climate aware projects will also cause a increasing demand for adaptation measures. This can be new commercially attractive opportunities for people who are interested in running their own business and private enterprises with climate adaptation measures, and it will expand a wide range of people's awareness.

Overall conclusion on Awareness:

The official research records showed that the general awareness of the urgency of adapting to climate change is quite high in Korea, however, in reality, serious adaptation to urban climate issues tends to be neglected. In particular, the knowledge on adaptation measures is lacking, and sometimes people even have wrong information about the use of effective measures. For example, South Korean cities should

review on their current investing strategies for green roofs on their actual effectiveness. More professional educations can help them make better decisions. Education has been addressed as the most effective measure for raising awareness of urban climate change, phenomenon, and measures among all groups. But the ways of current education should be reviewed and improved. Educations offered by South Korean cities are mostly about general climate change but rarely focus on providing information and knowledge for adaptation measures. Appropriate types of educations need to be offered depending on the positions of the people groups.

Citizens will become truly aware of the urgency of climate change when they get actual and personal experiences on their local climate issues. Therefore, education with focus of interaction and active participations will be more effective to inspire citizens, thus their 'real' awareness can be raised.

Although South Korean urban planners and designers already seem to have interests and knowledge on climate adaptation, they have acted little on implementation and application of their possible abilities. Two main causes are identified from the interview answers. First, only very little climate responsive project opportunities were given to them to be involved, thus most of planners and designer rarely have experience in climate responsive design. If 'climate aware project briefs' would be actively offered by politicians, planners and designers will understand their important role for adaptation through involving the projects.

Provision of high level education such as evening lectures or lifelong learning programme will support designers to get appropriate technical knowledge in regard to creating climate responsive design solutions.

The other main reason of the lack of actions of planners and designers in implementation is caused by the insufficient communication among professions. This issue will be later elaborated in the next 'communication' chapter.

- Discussion on the implications for the 'designing' disciplines

As it has been addressed, the answers on ‘Awareness’ part clearly conclude that actions for urban climate change adaptation remain a low priority in the public perception with low awareness of its importance. What does a design can do to improve this result?

1.) to offer citizens ‘more effective education’ through meaningful experience.

Seeing landscape or designs as an object which offers aesthetic experience, people are able to experience them in their daily life while they interact with them. And experience through revealing landscape/ design can educate people very effectively (Koh, 2013, Swaffield, 2002). Therefore, successful climate responsive design can also be a vehicle for educating people about climate. As an example, Lenzholzer (2010, p.152-p.153) introduces the possibility of design proposal for climate-revelatory elements which can change their form with the forces of microclimate. These kinds of design can show the ever-changing patterns of microclimate and make them more ‘experience- able’. As this example explains, it would be possible that people visually and physically learn about the short and long-term benefits of adaptation measures while they interact with explicitly climate responsive design elements. Thus genuine education can come through the embodied experience.

2.) to raise municipal concerns to commission projects with 'more climate aware project briefs'

Controlling urban climate, such as cooling UHI by physical land use planning and design is still a new concept in South Korea. To introduce how a climate responsive design project can cause a wide variety of beneficial effects in urban climate and the local society, it would be helpful to implement one exemplary project in order to set an example for good adaptation practice (Lenzholzer, 2015, p.79).

The success of realized design project will ensure that the climate responsive urban landscape solves the technical, scientific, and social issues that effected to the locals. The highest level of local public benefits generated by the design will encourage governments to recognise the importance of landscape-level policymaking and commissioning of design projects.

3.2.2. Communication

Q 1. Which roles do citizens, politicians, planners and designers and urban climate experts have in the process of planning, designing and implementing urban climate adaptation measures?

The answers for the roles of different groups can be summarized as follows;

Citizens from the group that experiences direct impact on their daily life, therefore they are the most vulnerable group to climate change.

Politicians are responsible in leading the process of planning urban climate adaptation and the successful cooperation amongst all groups of people. Their engagement can motivate people's active participation in communication process.

Urban planners and designers generate practical solutions in terms of developing adaptation measures with spatial and architectural knowledge. Their participations in the actual planning and design projects are very important to create climate responsive urban environment.

Urban climate experts have responsibility of supporting other groups of professions by providing scientific and technical knowledge.

Q 2. What are the relationships between these actors in the communication strategies?

Basically, most of interviewees were lacking confidence to clearly

define the relationships between different actors in the communication strategies. Only few answers were given. For clear understanding of the given answers for relationships between different actors, a diagram has been generated as in Fig.3.2.

Fig.3.2 Roles and relationships among different actors

Q 3. What is the role of communication to support the planning, design and implementation of adaptation measures?

Interviewees gave various answers for the role of good communication. It includes;

1.) to raise educating activities by sharing information. (This information includes problems, measures, and the knowledge for successful implementation.)

2.) to promote motivation and actual actions.

3.) to get agreements among different groups of people.

4.) to help design appropriate solutions and innovative ideas. (For example, designers can discuss their design proposals with other professions such as climatologists to get technical, knowledge support.)

5.) to promote citizens' participation, thus to create a people-oriented thermally comfort city.

So, communication can act as the main method which lead the entire process of implementing climate adaptation measures.

Q 4. Are there formal guidelines or policies that drive the use of communication in the planning, design and implementation of adaptation measures? If yes, can you please name them?

None of cities seem not to have specific communication strategies with regard to urban climate adaptation. None of interviewees were sure if formal guidelines/policies exist for communication. This implies that current communication processes have been unsystematically

conducted without any concrete guidelines. Despite of this fact, all informants are highly aware of the importance of communication and the need for improvement.

Q 5. What are the strengths and weaknesses of the communication process?

Strengths:

1.) New solutions can be generated through discussions in the process of the communication.

2.) Good communication processes can offer opportunities that all people can share their ideas with people from other disciplines. Because they are from different backgrounds, people from different disciplines would like to learn from each other.

Weaknesses:

1.) An increase in the numbers of engaging people and disciplines can bring more conflicts because all different people groups have different interests.

2.) In South Korea, scientists have often been central of the communication in the process of climate change adaptation and too much of focus often has been stressed on climate experts. Other people groups except climate experts take passive attitude during the communications, because they are not confident in their knowledge for climate. Balance and all groups' active participations are required since scientific knowledge is not sufficient to make real actions.

Q 6. Is there need to improve the communication process? If yes, how to improve?

The respondent from Seoul municipality was the only one who has positive opinion on the current communication systems of Seoul. The others, urban landscape designers and climate researchers express negative opinions on the current communication process. Informants from Suwon municipality believe their current communication progress and system are good, but they suggested better coordination and cooperation between planners/designers and politicians/government for improvement. In Daegu, more frequent communication is required between planners/designers and climate experts. Current one-way communication is problematic, more room for dialogue and all groups' active participation is required.

Overall conclusion on Communication:

The importance of the role of communication in climate adaptation has been recognized in South Korea, but the processes of communication are conducted unsystematically without any particular communication strategies. The current communication system seems to be problematic in South Korea. In particular, climate experts are active in a 'top-down' communication but planners and designers often take passive attitude. Despite the fact that planners and designers have some relevant knowledge and have recognized their possible role for climate adaptation, they seem to be lacking in confidence to discuss climatic aspects. This is also due to the fact that they seldom have concrete project opportunities in regard to climate adaptation.

I see that this problem is related to the lack of communication between planners/designers and politicians, which is a significant barrier to implementing climate adaptation in South Korea. Because they did not communicate effectively, climate aware commissions of projects

has not been offered enough by politicians, and the opportunities for developing innovative climate aware design projects were missed by designers.

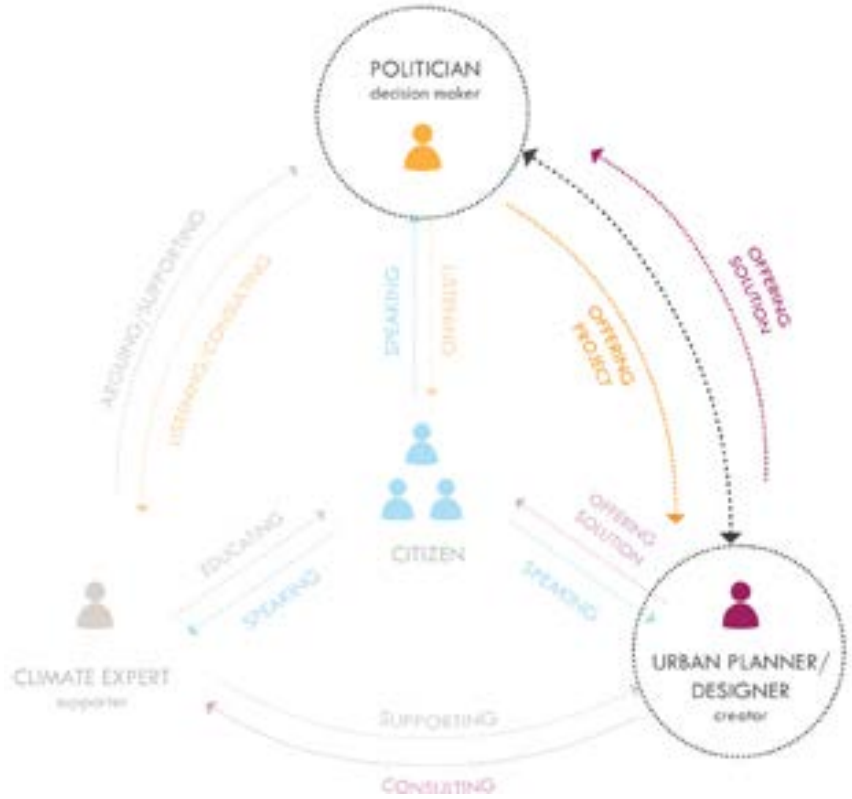


Fig.3.3 The biggest problems and potentials lie in the communication between politicians and urban planners and designers.

- Discussion on the implications for the 'designing' disciplines

1.) Design can make invisible visible by concrete images and forms

It has been studied by several scholars to identify the reason why people are not concerned about climate change and why it is difficult to communicate. Moser (2010) addressed that the biggest barrier to communicating climate is its invisible and temporal characteristic. This barrier can be overcome through the visualizations of climate since images and forms are powerful tools for getting a message across. In general, design is capable of formulating innovative answers to complex problems, beside this function, design is also about to create images and forms which make abstract thoughts to visible. Some scholars, such as Roggema (2009) emphasizes that design is an effective tool to communicate a changing climate through giving form spatially.

2.) Design can propagate stories of regional futures

Moreover, through the presented images in concrete forms, designs also can persuade and tell us stories of the future. The narrative design makes visible what a future world may look like and how society will function under new conditions.
To adapt cities to the changing climate, the appropriate policies should be in place (Shaw et al, 2009). However, Van Dijk (2011) points out that ambitions in policies are abstract, fuzzy and sometimes confusing. Abstract ambitions, cast in universal terms, are therefore hard to base decisions or actions upon, especially without knowing exactly what they will mean for the unique contexts of people's lives. According to Van Dijk, designs can fill gaps regarding the precise intention of a project, examining the consequences of planning by confronting abstract ambitions for the future with practical restrictions and the range of possibilities for the physical present (Van Dijk, 2011).

Therefore, aspirations for spatial change need to be translated into concrete design. This will help to build the capacity to communicate and engage more effectively with politicians and public officials at the levels of key decision-making.

3.3.3. Instruments

Q 1. Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures? If yes, please explain how they work?

In South Korea, multi-level governments and municipalities seem to play a key role in climate adaptation through their current statutory duties. The main promoted way for adaptation is by finding linkages to environmental planning. However, emission trading, the legally binding policy instrument proposed by interviewees, is about to control energy consumption behaviour. It is basically not directly relevant in controlling the impacts of urban climate phenomena.

Q 2 & 3. Are there certain chances/ potentials missed when using the legally binding mentioned instruments (e.g. coupling with other instruments) ?

As it has been addressed in Question 1, interviewees did not give sufficient and relevant answers on the legally binding instruments. Therefore Question 2 and 3 were also not relevantly answered to discuss.

Q 4. Are there other policy instruments used to implement urban climate adaptation measures? If yes, please explain how they work?

Again, interview results showed that not many policy instruments exist

to implement climate measures in South Korea. An interviewee pointed out that there are some regulations which require developers to set aside green space in new developments. In pushing both climate mitigation and adaptation planning, national government and local environmental planning agencies have collaborated to create more green spaces, for example, by building greenways, city forests, and ecological parks on sites that were previously built-up areas. However it seems that many of planners and designers are not well aware of the presence of the regulatory policy for green spaces. Therefore this policy intervention is not concretely implemented and used.

One interviewee of the landscape architect of office PARKKIM, suggested the creation of new policy which obliges architects and designers to actively apply climate responsive design. She expected this kind of regulation would also promote the cooperation amongst climate engineers, urban planners and landscape designers. If such policy is implemented successfully, a good system could be set up to create cities respond to climate aspects.

Q 5. & 6. What are the strengths and weaknesses of the other policy instruments used?/ Are there certain chances/ potentials missed when using other policy instruments (e.g. coupling with other policies)?

From the result of Question 4, it was found that Korea is lacking in the variety of policy instruments for adaptation measures and Question 5 and 6 were not appropriately answered by interviewees.

Overall conclusion on instruments to implement climate adaptation measures:

From the interview results, it was found that South Korea is lacking policy instruments for implementing adaptation measures. It seems that not many legally binding instruments exist and the mentioned instruments are basically not directly relevant in controlling impacts of urban climate phenomena. For example, emission trading, is about to control energy consumption behaviour and more relevant to mitigating urban climate. This means that there is unclear classification between mitigation measures and adaptation measures. South Korean urban policies are much aware of mitigation by reducing CO2 emissions, but climate adaptation has not been effectively prepared in policies and planning.

- Discussion on the implications for the 'designing' disciplines

In light of large interventions to improve the urban climate, legally binding implementation instruments can be one of the most effective tools (Lenzholzer, 2015). Therefore, the interview result of 'instruments' part clearly indicates the need to raise awareness of municipal officials to develop concrete policy interventions that help to implement climate adaptation measures. So for design, I would like to highlight the role of a design with a focus on the communication of specific adaptation measures. It would not only effectively educate both politicians and citizens to have knowledge about using adaptation measures, but also promote their actions which go beyond general climate awareness.

3.3.4. Implementation

Q 1. Which concrete urban climate adaptation measures/ interventions are currently implemented or have been implemented in your city?

Urban vegetation seems the most concrete and common measure at present. Special emphasis has been attached to implementing green roofs on existing buildings among South Korean cities, although its effectiveness has not been confirmed.
In addition, short term measures for managing emergent moments were also explained as the current actively implemented measure. This includes offering alert system, temporary shelters for extreme heat wave, fog and misting systems for rapid outdoor cooling and emergency medical care in the event of climate disaster.
There is a growing interest in use of materials and creating wind corridors for air ventilations, but these have not been concretely implemented in practices yet.

Q 2. What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

Urban vegetation in buildings can increase the risk of fire hazards, and contribute to increased levels of pollen, leaves and dirt on mechanical units. The cost and labor also can be quite expensive to maintain urban vegetation such as rooftop gardens and walls.

Q 3. Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

None of interviewees sees any strong aesthetical conflict with adaptation measures. Mostly, interviewees answered that urban vegetation enhances aesthetical values of cities.

Q 4. Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

If urban climate adaptation measures collide with urban functions, that mostly comes from conflicting interests of different actors such as government and individuals. Regulatory measures often conflict with private businesses, economics and industrial developments. For example, implementing urban vegetation on existing buildings can conflict with different property owners. There are also cost-based conflicts associated with the construction and maintenance of urban vegetation.

Q 5. Are there certain chances/ potentials (e.g. coupling with other interventions)/ 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

Most of interviewees did not give clear answer for this question. Only one interviewee, climate expert, Haedong Kim, just emphasized the integrations among different measures to generate multi-functional benefits.

Overall conclusion on Implementation:
South Korea has prepared for adapting urban climate by considering both short and long term measures. Short term measures such as alert systems, emergency medical care, temporary shelters, fog and misting are quite successful in its implementation. However, these measures are

all too temporal and only for the emergency cases. Addressing the long term use measures, the variety of concrete measures was very limited. Only urban vegetation was mentioned by some respondents during the interviews, however this also seems not to have been successfully implemented because of barriers such as conflicting interests, and cost-based conflicts associated with the construction and maintenance of urban vegetation.

In order to enhance the current situation of limited preparation, it will be very important to define first the reason why city governments actively prepared for short-term adaptation measures but not for long-term measures. By the same token, it would be also important to consider the reason why the strategies for adaptation are weak whereas mitigation measures are well prepared in their urban policies.

According to Moser (2010), most people perceive the impacts of climate change as temporally and geographically distant. Therefore it is also easy that governments put a bigger emphasis on preparing measures for only emergency cases or preparing measures for mitigating climate change of the far future. The adaptation measures suggested by interviewees actually can be applied in any cities of any countries, but they are not specialized particularly for their specific local climate situation and issues. This fact implies that South Korea is lacking in realizing the real local climate problems that will influence negatively to their current and future local society. To expand the variety of the types of long-term measures, local/district level information and knowledge are required for supporting each locals and districts to get the relevant adaptation options. Provisions of district scale application guidelines and tools for climate change adaptation are also required.

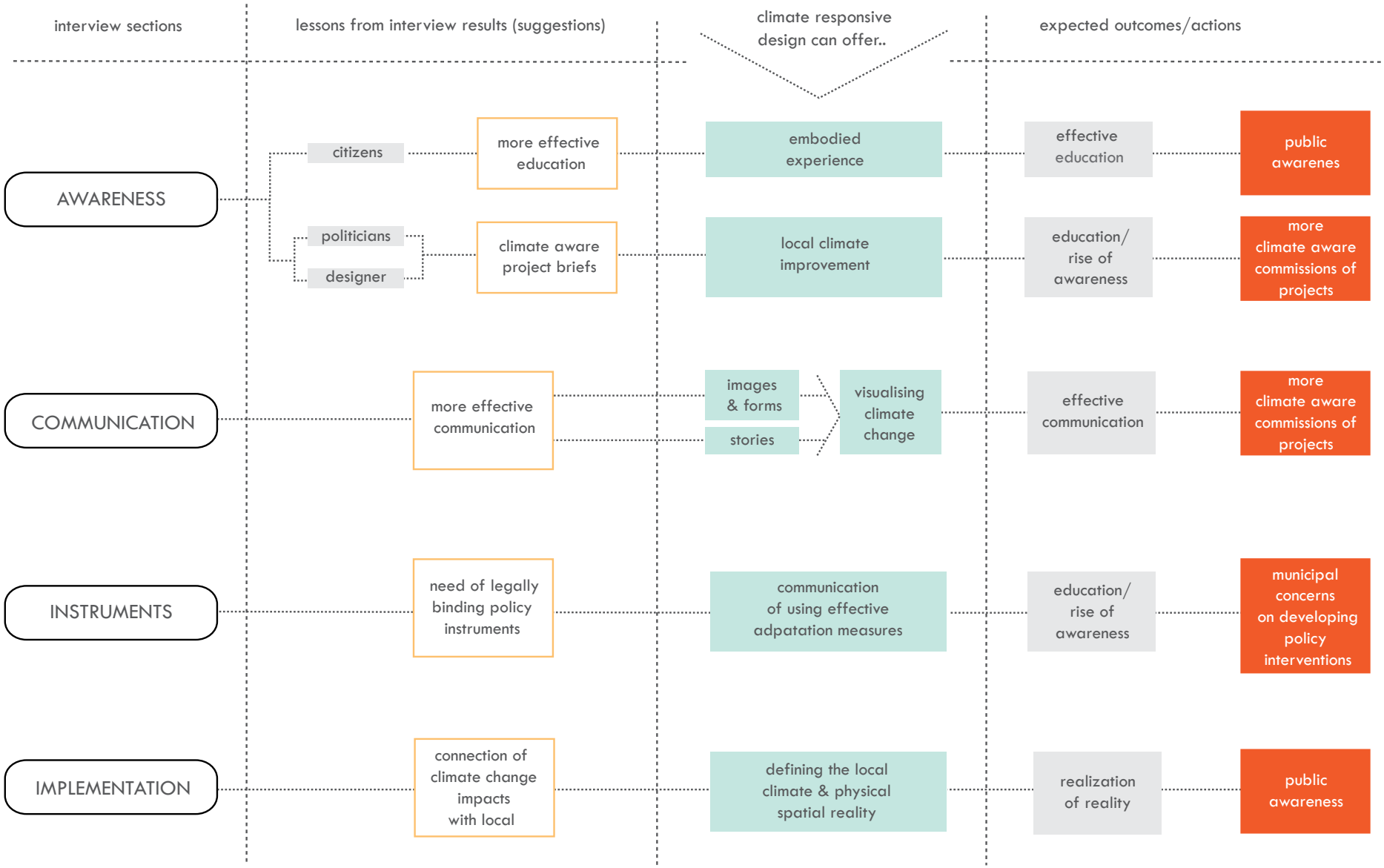
- Discussion on the implications for the 'designing' disciplines

Designs mould regional realities

As Van Dijk explained (2011), in their role of translating ambitions into spatial structures, designs above all help regional communities to first define the physical spatial reality they live in. This awareness shapes the construction of reality, affecting local attitudes and individual behaviour. Perceptions of reality are constantly reconsidered, with designs potentially being part of that ongoing reframing process. Therefore, design can play a key role to bring the realities of problematic climate change to the local community level. Through interacting with the design, people will realize the realties and want to be more personally connected to their municipal concerns on preparing appropriate measures for their local climate conditions (Schroth et al., 2014).

For clearer understanding of how actually these implications will be applied in practice, it may be helpful to explore on some example climate adaptation designs that is successfully realised in elsewhere. Example projects will be also beneficial to get inspirations for design in further step to apply these finding.

Fig.3.4 Comprehensive conclusion of interview results and discussion of implications of climate responsive design



As shown in Fig.3.4 in p.40, comprehensive conclusion on the interview results are summarized.

Considering the interview results, two aspects of ‘functionality’ and ‘revelatory-ness’ are classified as the major categories of implications for climate adaptation design in particular with regard to climate adaptation situation of South Korea.

The relation between these two aspects and discussed potential outcomes of climate responsive design are linked in the graph of Fig.3.5.

In later chapters, this two aspects will be more precisely defined and developed to strategies for achieving design aims.

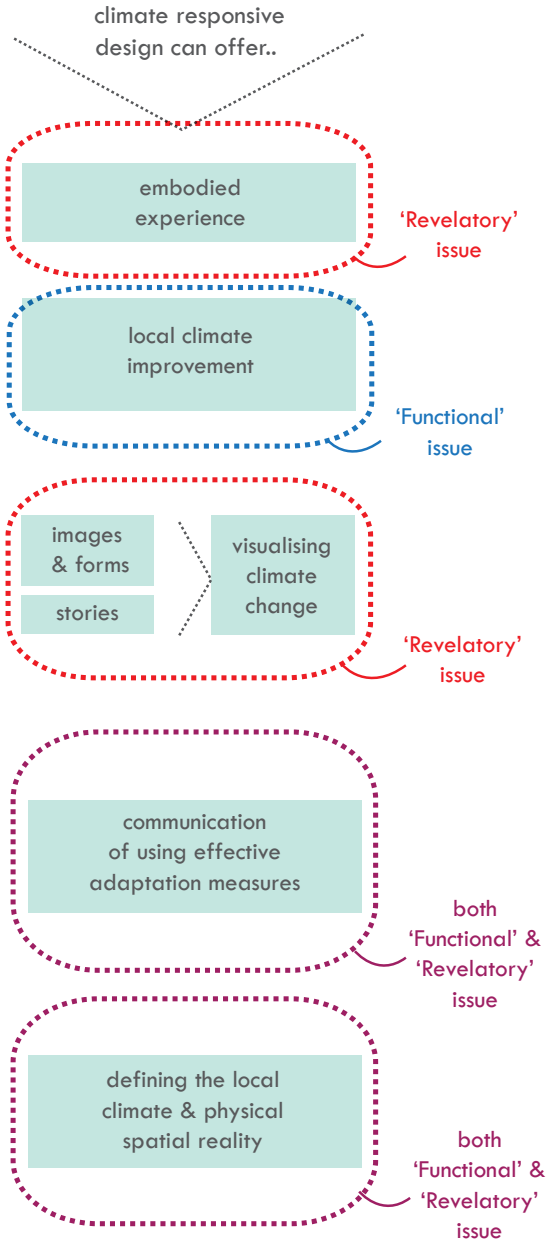


Fig.3.5 Two main aspects of implications for ‘climate responsive design’ in regard to current situation of South Korean urban climate adaptation


노매드전용별

Chapter 4

Part B: Research through designing - an exemplary design

In previous chapter, based on the earlier research and analysis, I argued about using climate responsive design not only to raise awareness and inspire citizens and politicians, but also to promote their actions for concrete implementation. In this Chapter, the activity to create a concrete design for a particular location in South Korea will be employed to test and prove my argument.

4.1. Introduction to the 'Design'

4.1.1. Design objective and goals

Considering the lessons and conclusion from the interview answers and discussions, the main design objective, goals and strategies are formulated.

In this study, the main design objective is to create an exemplary design which can set an example to South Korea for good urban climate adaptation practice.

Following the main objective, the final design product will aim:

1.) to enhance climate comfort in not only city level urban environment but also human level thermal experience.

2.) to communicate effectively the importance of adaptation to inevitable climate change.

Four design goals were established in accordance with above main objectives:

1.) Clearly define local climate issues and physical spatial problem of the site, then provide effective measures based on the analysis and scientific data.

2.) Make the place interact with people and offer them opportunities to learn about urban climate change and how to adapt with appropriate measures.

3.) Design a place which immerses people in various and meaningful microclimate experiences.

4.) Translate the story and ambition for the positive future climate of the city into concrete images, forms, and physical elements in the design.

4.1.2. Conceptual design strategies

In order to effectively achieve above design objectives and aims, design strategies are conceptually considered with two different aspects.
On the one hand, the final design has to come up with solutions that work functionally to adapt and enhance urban climate. On the other hand, to make the design culminate in a distinct educational experience for those with limited climate change awareness and knowledge, there is also a requirement for interventions which deal with 'climate-revelatory' elements.

Although I divide the strategies with two distinct aspects, there will be the common ground that some interventions can be situated. Because some design devices are able to work for both functional purpose, and revealing and education purpose at the same time. (refer Fig.4.1)

This conceptual strategy of combination of 'functional' and 'revelatory' design will lead to create interventions in later design implementation part as the essence of approach for design achievement.

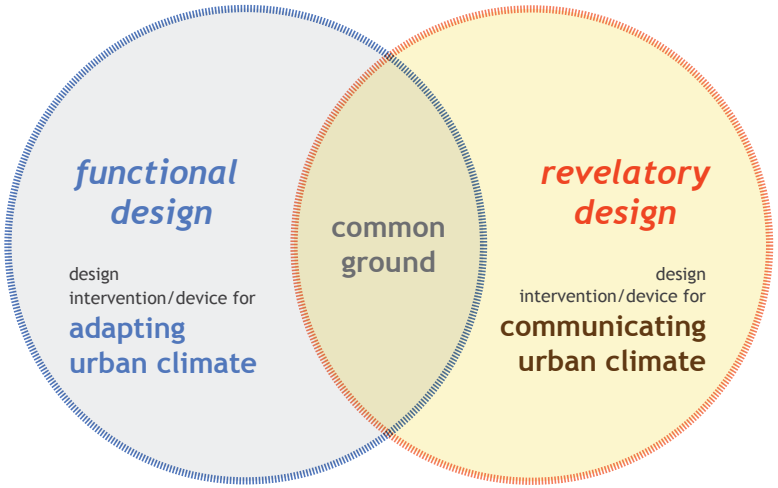


Fig.4.1 Conceptual design strategies; functional design vs revelatory design

4.1.3. Site selection based on climate analysis

Scientific research interest and capacity in South Korea is strong. Based on this advantage, a few cities in South Korea created 'urban climatic map'. In the case of Seoul, climate analysis model 'CAS (Climate Analysis Seoul)' was developed to provide realistic climatic information considering local air temperature and wind flows. (Yi et al. 2012). Reviewing on the data from CAS at city scale level, I was able to determine the influence difference between built surfaces and natural/vegetation areas on near-surface air temperature and wind conditions within the Seoul metropolitan area.

As it is shown in 'Analysis map of surface influence' (Fig.4.2-(a)) and 'Analysis map of air temperature deviation' (Fig.4.2-(b)), most parts of inner city areas of Seoul are exposed to the UHI effect. However, potentials were also found in transitional areas of cooler and warmer air which create ventilation.

Based on these findings, I decided to choose my design site within the 'Jung District' (Jung-gu: literally meaning 'Central District'), which is one of the urgent districts to stop warming but also can benefit from the surrounding potential area for ventilation based on wind. (refer Fig.4.3)

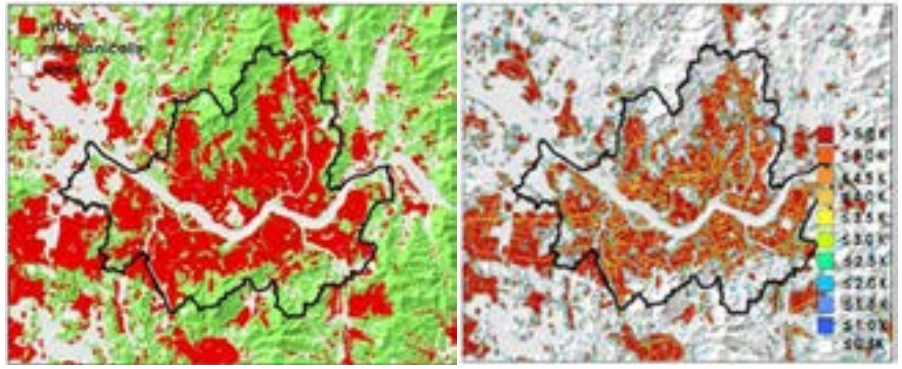
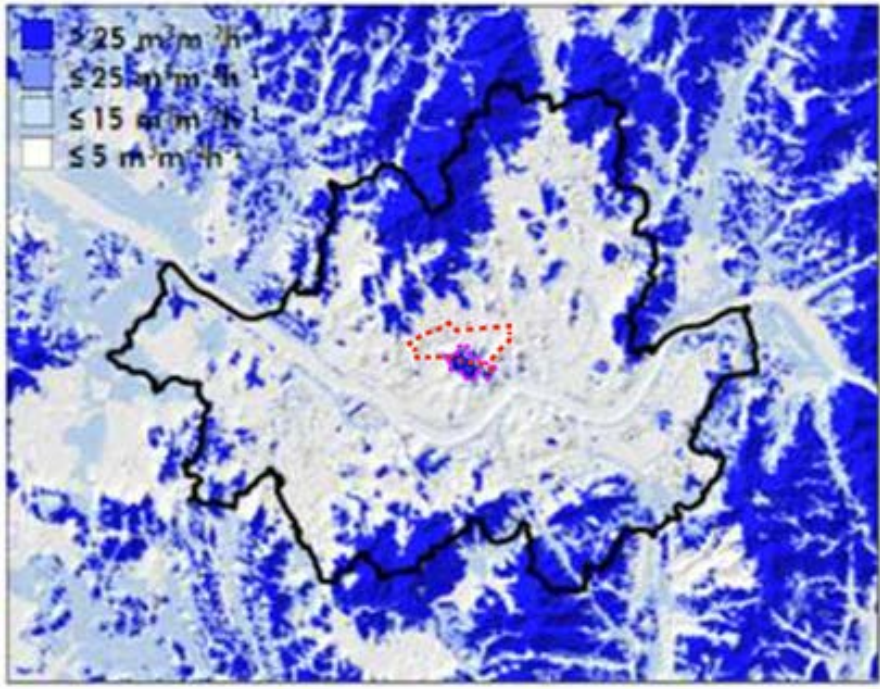


Fig.4.2 - (a) Analysis map of surface influence (left), (b) Analysis map of air temperature deviation (right)



boundary of district 'Jung-gu'

potential of cold air production

Fig.4.3 Cold air production and selected site location

Fig.4.4 Site photo - Seun sangga complex

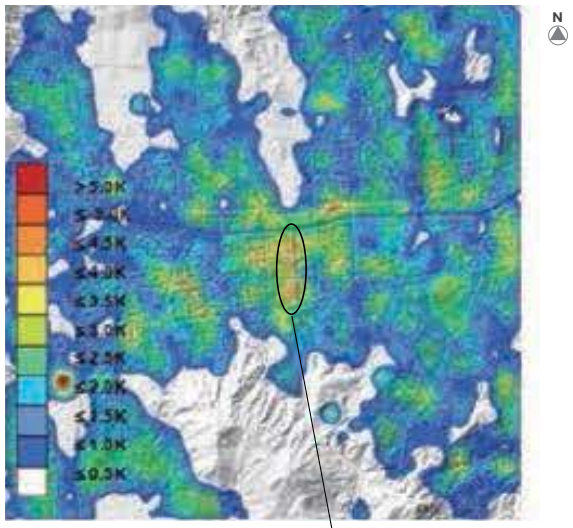


Fig.4.5
Air temperature of the study site and surrounding area

Fig.4.6 Megastructure - Seun sangga complex consists of 7 buildings

Exploring for the selection of design site focus for micro level scale, one huge giant concrete building in the Jung District caught my eyes.

Seunsangga Complex, is a 50 meters wide and 1 kilometer long mega structure constructed from 1967 to 1972. It was Korea's first mixed-use building that combined residential and commercial spaces as well as amenities which gained popularity among noted public figures at the time. Once it was a symbol of futuristic, luxurious architecture in the center of Seoul, however, at the present it is slowly getting abandoned.

Recently the Seoul Metropolitan Government has paid attention to revitalize this giant architecture and surrounding districts, and had released the commission of design competition. From the point of view of climate aspects, Seun Complex is very problematic in terms of urban heat and thermal comfort. As it is shown in Fig.4.5, the air temperature of surrounding Seun buildings is particularly higher. Considering not only this climatic data, but also its scale, architectural structure and surface materials, there is no doubt that the thermal environment of the site negatively affects citizens and their daily lives. However, this fact is ignored in government's development plan.

Therefore, I decided to design for a part of this site with focus of climatic considerations combining with design aims, objectives, strategies that I formulated in previous section.

4.1.4. Process of designing

As the first step of the design process, the inventory investigation and analysis is necessary for in-depth understanding of the study area and its context.

Although this research concentrates on 'climate responsive design', it must be seen as part of larger picture. As Erell et al. (2011) addressed, urban climatology is mainly concerned with the overall urban area and its effects on the lower atmosphere. Employing scientific data and knowledge of climate in a design must not only be seen as the single basic determinant of design. Built environments must satisfy a range of functional criteria - structural, environmental, economic, social, organizational, visual, and so on. These functional criteria are independent, in that they are nothing like each other but are interactive (Hillier and Penn, p.332).

In this study, therefore, the inventory analysis had been carried out to obtain not only primary climatic factors determining the local climate of study area, but also information from other independent criteria.

Acquiring a comprehensive understanding of the environmental context of the study site, the inventory analysis aimed to identify the problems and potentials of the site in regard to both climatic and general urban design aspects. This helped to bridge the gap between climatology research and applied urban design which is very important for successful implementation of the climate responsive design integrating existing context and problems of the site.

The analysis, consisting of an inventory and evaluation of the problems and potentials, is the basis of the final design of the study. In following chapter, the outcomes, design solutions will be explained based on the conclusions that have drawn from the analysis.

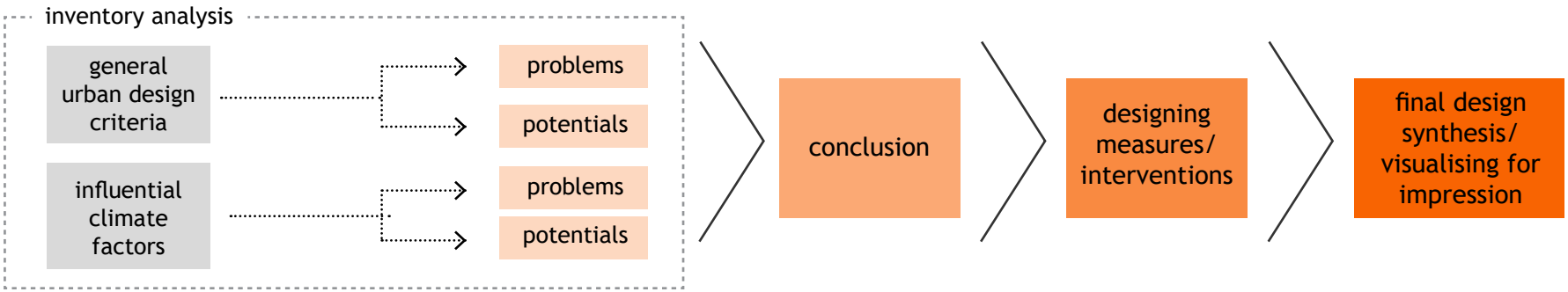


Fig.4.7 **Process of design implementation**

4.2. Identifying the study site's general urban design issues

First off, this research conducts site analysis on the general urban design criteria. Considering the conclusion drawn from the general urban context analysis, the main design concept and idea has been created as the starting point of design proposal developing. In this section, the general urban context analysis and ensuing conclusions are developed under the framework of the developing design concept.

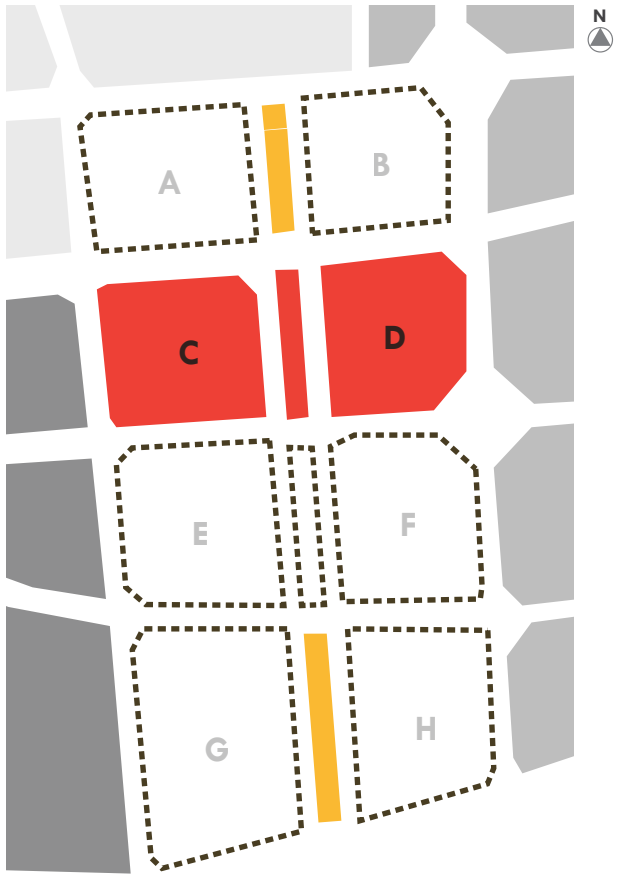


Fig.4.8 Urgency and potential map for changing use of buildings/districts

4.2.1. Urban decline and potential for changing use

In the past, together with surrounding districts, Seun buildings had been creating a hub of secondary industries, such as iron goods, lighting, and jewellery in the central urban area. However, business in this market area declined rapidly since internet markets have been actively developing. (See p.125 & p.137 in Appendix 3 for more information on this site's industry and the change in land use and demography structures.)

With the urban decline caused in turn by the business decline of the site in question, the shops and buildings over 46 years old are currently in very bad condition. In particular, as it is shown in Fig.4.8, District C and D almost went to ruin, calling for the site's redevelopment by changing its use as well as improving spatial qualities.

Erasing a 1 kilometre long group of Seun buildings at once and building new ones will cause more problems and would not be ideal to the people who work and live in these areas.

For the design presented in this research, therefore, it is decided to focus on redeveloping only one building, 'Dae-lim', which is located beside the most neglected districts, District C and D, instead of changing the entire series of seven buildings. (Fig.4.9)

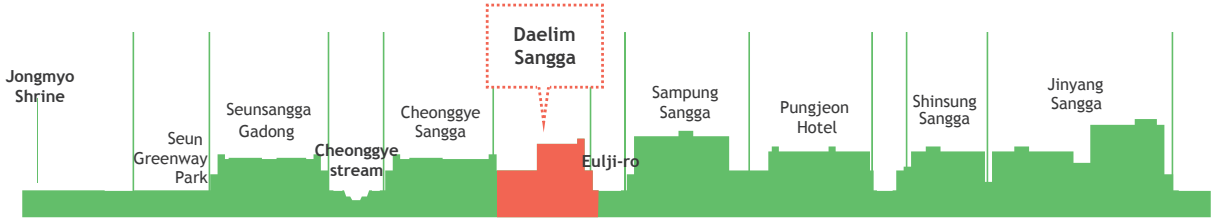


Fig.4.9 Design focus area

4.2.2. Transforming the ruined building to the first urban climate park of Seoul

In addition to the urban decline issues taking place in the site area, inventory analysis concludes that the area is also lacking both green and open space (Refer p.127 in Appendix.3 for more detailed information on green space context.).

In taking this into account, the author proposes to transform the most ruined building in Districts C and D into a place able to function as contemporary urban parks, along with its positive benefits on those coming in contact with them. The design proposal suggests for the original basic structure of the ruined building to remain, using it as the foundation for a new park. As such, visitors will remember the original story of the old building yet feel inspired by the structure's transformation.

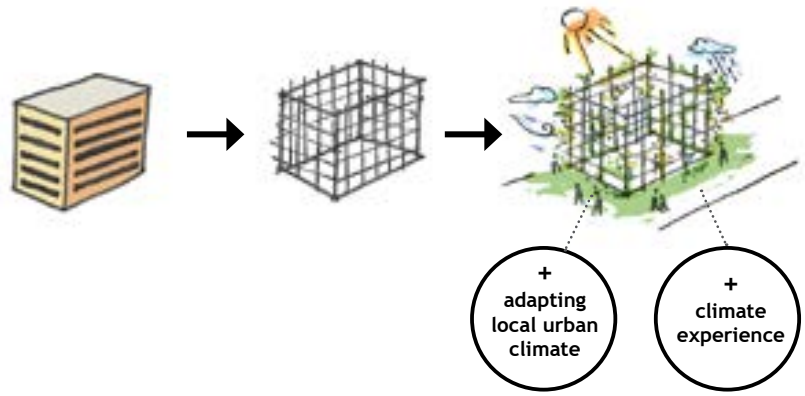
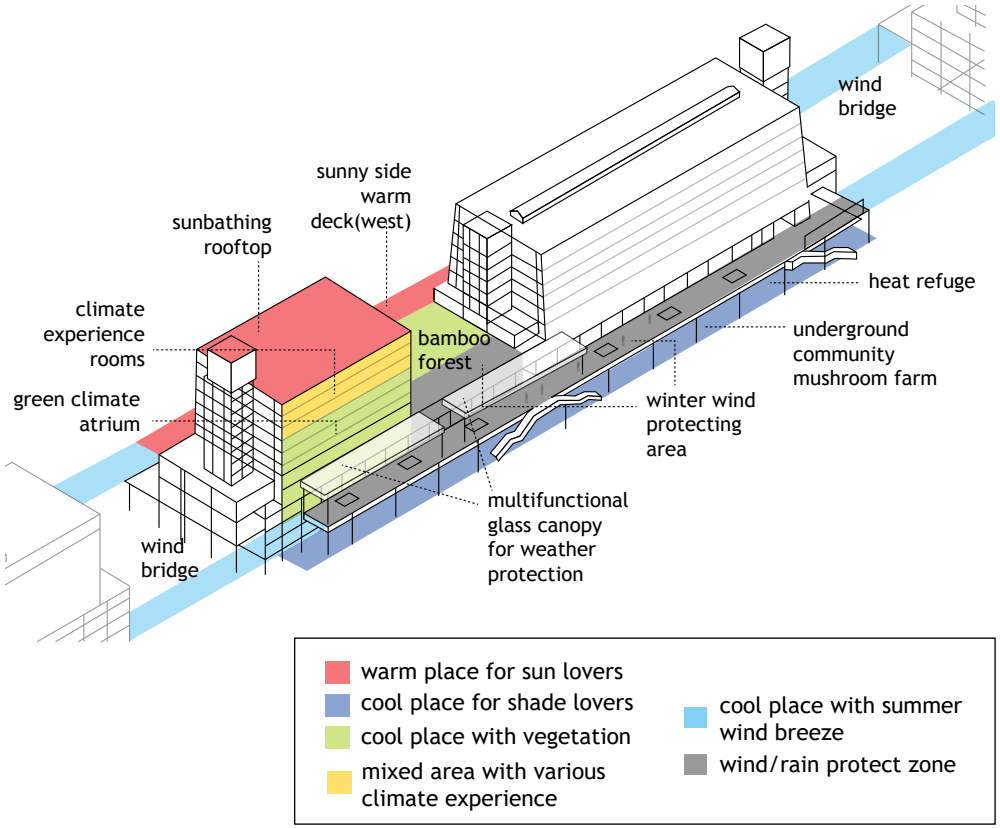


Fig.4.10 Design idea: Transforming ruined building to urban climate park

Unlike common urban parks, the transformed new park will aim to provide a set of various microclimate experiences to visitors. Fig.4.11 addresses how the programmes for climate experiences will be applied into the new park and surrounding spaces. The decision for programme design is based on the combined analysis results of microclimate situational and spatial/structural understanding.

Fig.4.11 Programme and climate experience in the park



4.2.3. Building accessibility and program design

Considering the original building condition of 42 metres height, suitable programmes for creating climate parks must be proposed depending on space accessibility.

As explained in Fig.4.12, first off, the convenience of entrance floors have been evaluated. Afterward suitable programmes are suggested depending on the result of accessibility evaluation.

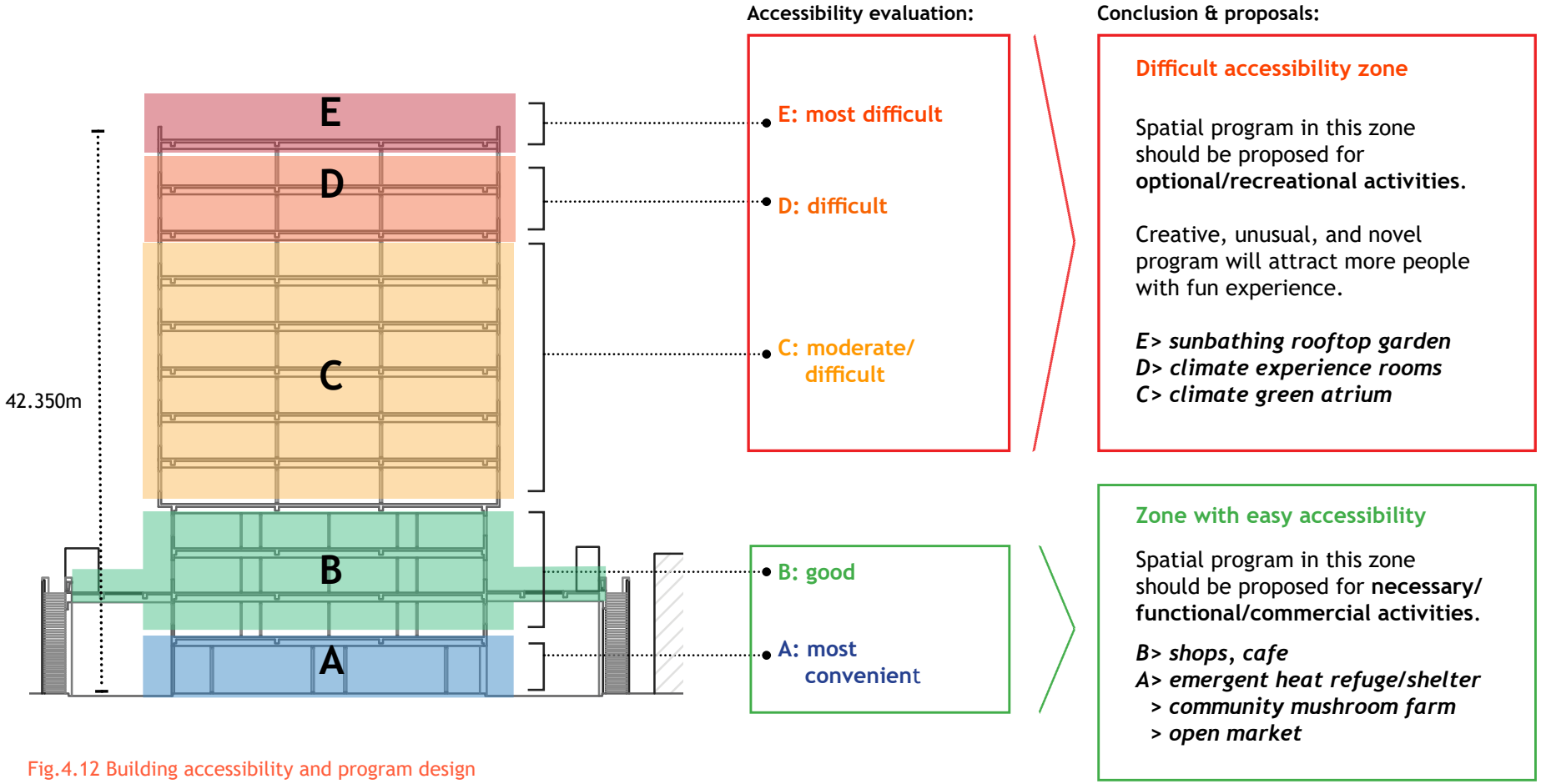


Fig.4.12 Building accessibility and program design

4.2.4. Feasibility study of architectural construction

In order to simulate and test the structural feasibility of the park's construction, the following 3-dimensional models have been produced.

First off, the existing building structure is modeled below. As shown in Fig.4.13, the original building is supported by the essential columns, marked with red in the drawing. In order to avoid collapse of the architecture, these essential columns must therefore be kept.

While these essential columns remaining in the final design, secondary elements like slabs, walls and windows can be removed (or remain if its needed) for creating suitable space to implement the proposed climate programme.

Fig.4.13 Original building structure

Fig.4.14 Designed park structure

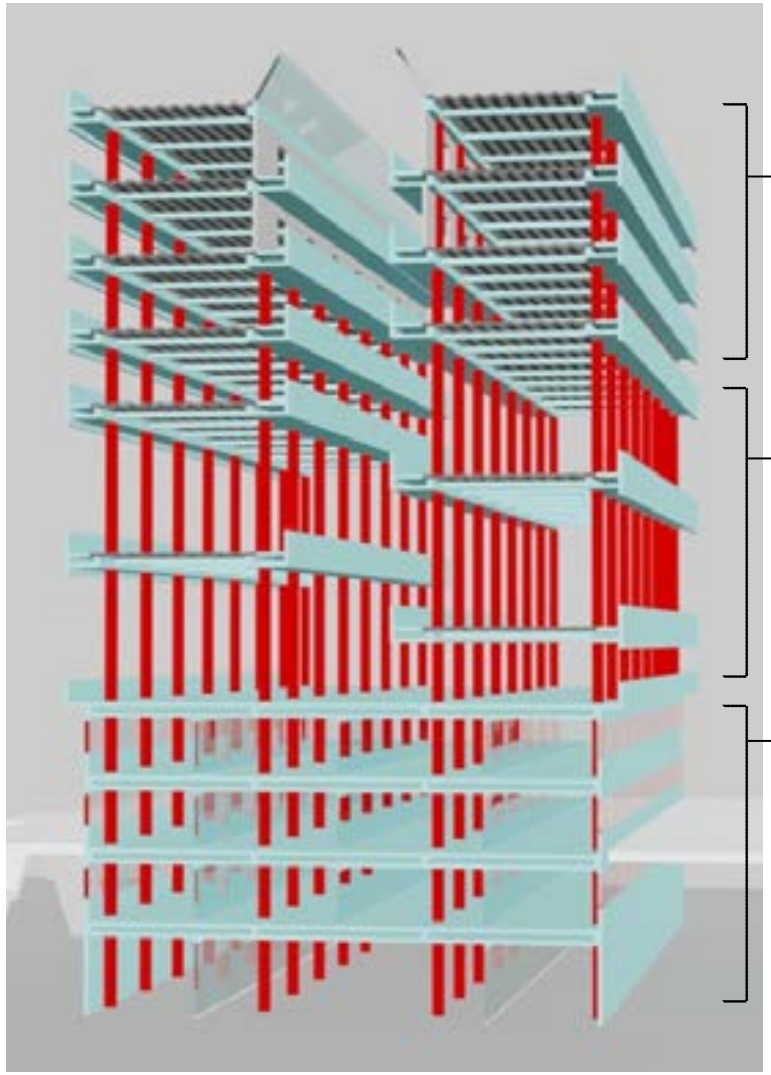


Fig.4.14 shows the final design structure, explaining how the building has been transformed and the justifications for each change implemented.

Climate experience rooms

In this section, many secondary elements remain and are utilized to create rooms allowing for the microclimate experience, as shown through the climate atrium with vertical green structures.

Climate atrium with vertical green structures

In this section, the majority of secondary elements are removed in order to allow for more sunlight to enter the building for growing vegetation. Moreover, the essential columns are used for the basement of climbers planting. Finally, some slabs remain in order to create a multi-level atrium park, where people are able to situate themselves.

Cafes, shops - commercial indoor area

This lower section keeps its original structures. As for the entire indoor section, all original windows also remain in place

Acknowledgments

The author would like to thank architect Ja Kim from Arch166, the architectural design office based in Seoul. She provided advice on the building's structural design based on her architectural knowledge specific to the urban contexts of Seoul. Thanks to her help, I was able to confirm the feasibility of my design proposal.

4.3. Designing park with urban microclimate

In order to design an urban park offering people a comfortable and pleasurable climate experience, scientific climatic knowledge must be translated into design knowledge.

As three influential factors of people's experience on micro-climate, the design in this study centers on 1.) the presence of solar radiation, 2.) the wind situation and how it affects the structure 3.) and precipitation.

Careful analysis on each of these factors is conducted in order to identify current structural complications and other potential issues . Subsequently, this study analyses the location-specific design interventions that can modify or utilize the existing conditions as an advantage in order to create certain microclimate experiences with specific purposes.

4.3.1. Influence of sun exposure

People's feeling of and interaction with shifting temperature is one of the most vital aspects to the overall microclimate experience. As such, it is the basis of all thermal processes on Earth, not least concerning incoming solar radiation and how it interacts with a particular building structure.

Therefore, taking into account people's temperature experience, it is important to pinpoint the locations and intensity of solar exposure on microclimate levels in order to apply and place design interventions as required.

Moreover, since sun and shadow have the greatest effect on the temperature regimes of objects on Earth, the heat intensity of the site at the street level can be assessed by distinguishing sun and shadow patterns (Lenzholzer, 2015, p.30-.31).

The heat intensity of building surfaces for the warmest summer period in South Korea is evaluated by shadow pattern studies. (All shadow simulations are carried out using the SketchUP program; refer p.131-132 in Appendix C.)

Given that cities with different geographical locations have different solar latitudes and exposure periods, this research considers the geographical conditions of South Korea in order to more accurately simulate the shadow patterns.

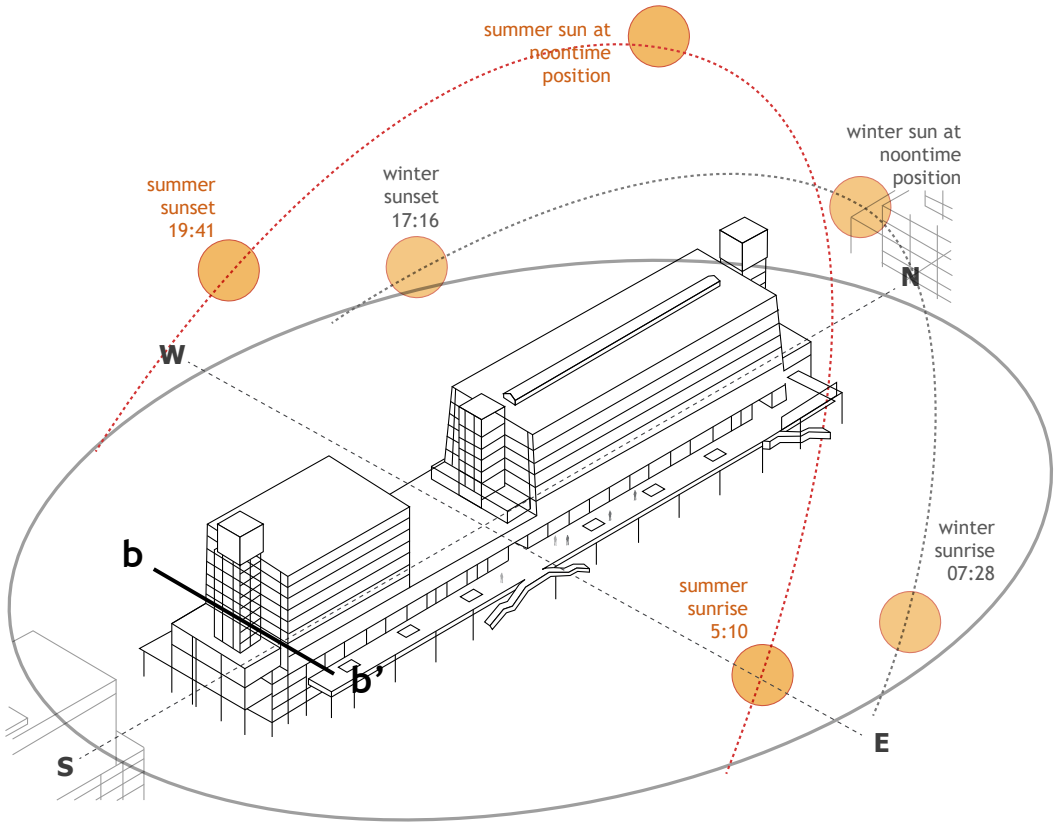


Fig.4.15 Summer and winter solstice

The results of the solar exposure intensity analysis are as follows:

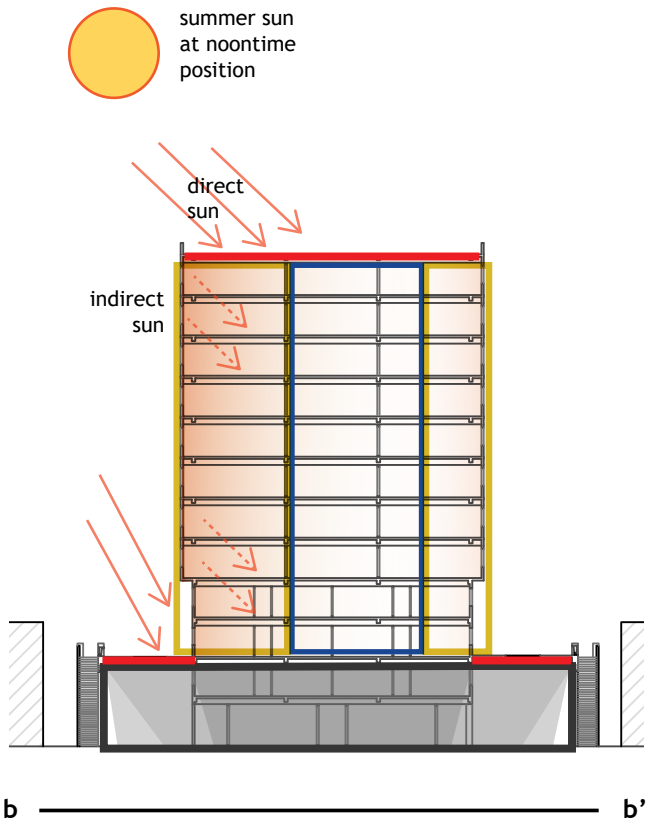


Fig.4.16 Existing condition
influenced by solar radiation

surface with the most intensive sun exposure

(a) Firstly, the surfaces most intensively exposed to the solar radiation are those highlighted with red lines. As shown in Fig.4.16, the roof top and both side decks are the most vulnerable surfaces to heat during warm summer days.

potential cool area with shade

(b) Secondly, those areas deemed to be potentially cool in temperature are represented by the shaded grey box in the figure above. This potential is created below both sides of the decks, in addition to the bottom part of the indoor space. Decks and walls that are non-transparent objects block out the sun light and cast deep shadows on this area as a result.

solar radiation intensity

potential area for growing vegetation

weak area for growing vegetation with less sunlight

(c) Thirdly,Depending on the intensity of solar exposure in indoor spaces, the potential and problem area are defined to apply planting schemes.
In Fig.4.16, the area within the yellow box represents those with favourable conditions for growing plants, whereas the area marked in blue will need modifications for plant growing purposes.

(a) surface with the most intensive sun exposure - roof top (left) and decks (right)

(b) potential cool area with shade - below deck

Design with influence of sun exposure

Considering each analysis results, design is developed depending on proposed climate conditions:

Firstly, place for warm thermal experience is designed in roof top, sunny deck (West side) area.

Secondly, place for cool thermal experience by shading is created in shady deck (East side). Heat refuge is designed at the bottom part of the park.

Thirdly, cool place with vegetation is developed in climate green atrium. Green facade is also suggested to be built on the building wall for cooling effect. Detailed information of design is explained in Fig.4.18.

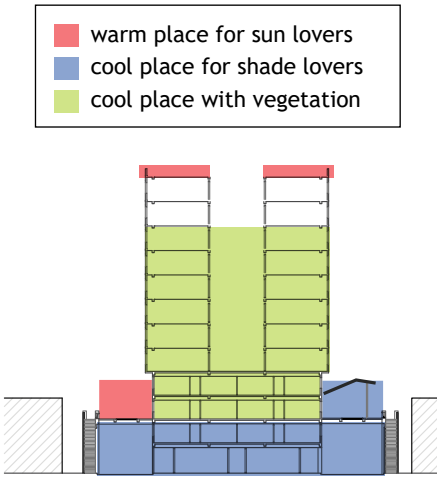


Fig.4.17 Proposed climate conditions
and potential visitors with climate experience

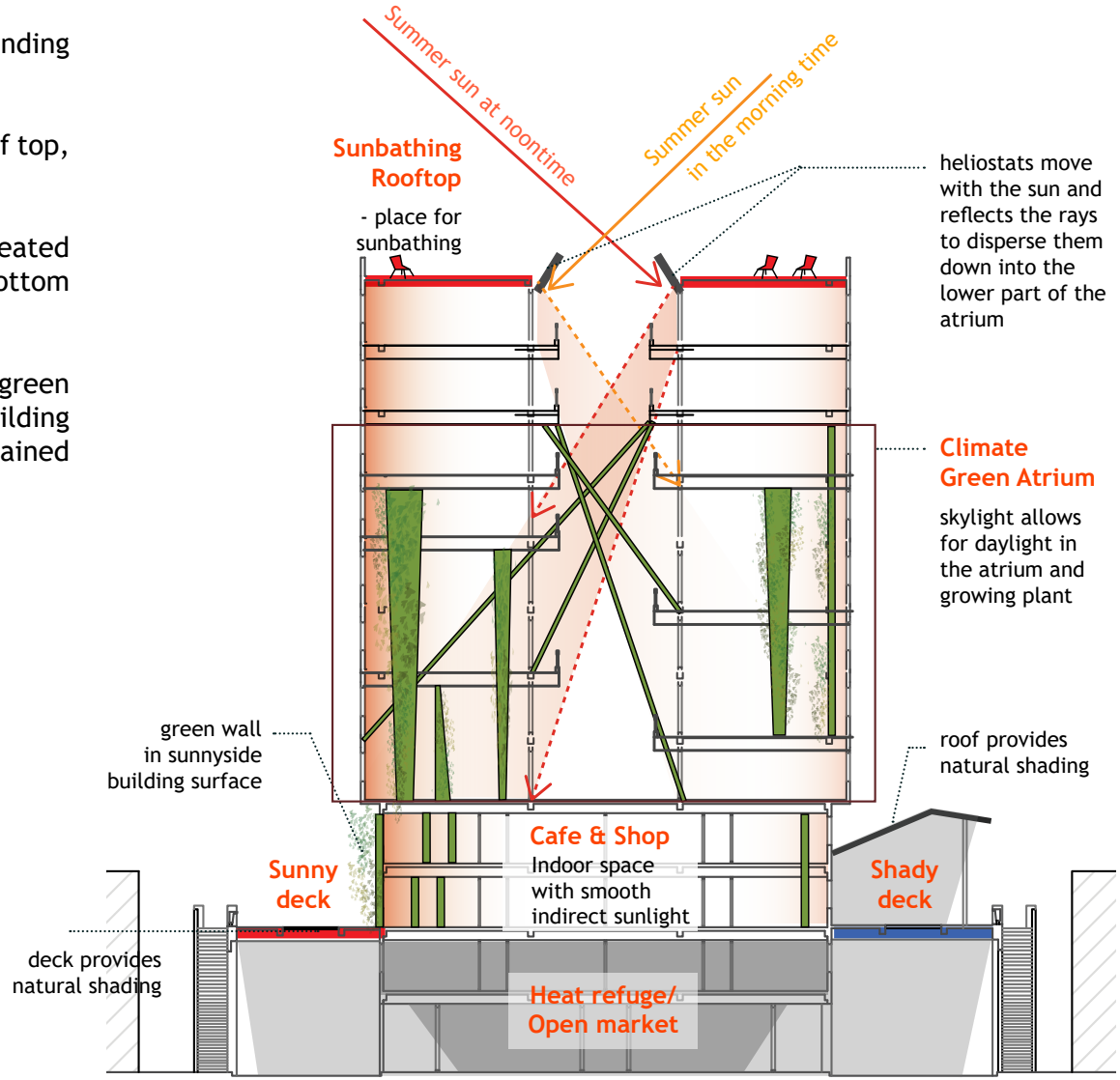


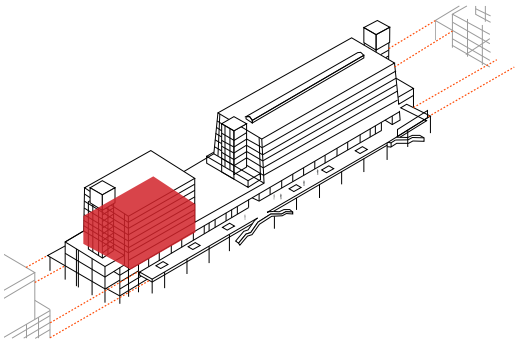
Fig.4.18 Design with influence of sun exposure

Fig.4.19 Existing situation: the indoor corridor area in Daelim building

Fig.4.20 Impression A:

Climate Green Atrium

Impression A shows that how the original building is transformed into the climate green atrium which offers both cooling effect and novel green experience to visitors.



4.3.2. Designing with local wind patterns

Two aspects must be understood regarding the design for physical wind experience.

First off, the flow patterns of wind in cities always depend on local contexts shaped by the unique building configurations. As such, these patterns can be predicted through a combined consideration of prevailing wind direction and flow principles that normally occur around certain building volumes and in specific open spaces (Boutet, 1987, Lenzholzer, 2015, p.42).

Secondly, wind flows in urban areas can be both a problem and a potential advantage. During cooler seasons like winter, people prefer to be protected from the wind. However, during the hotter seasons which may include heat waves, sufficient ventilation with cool breeze is in order. The latter point is especially important in designing the use of space and how people can engage in different activities with it (Lenzholzer, 2015, p.109).

Having considered these two aspects, this research first carries out a careful analysis of prevailing wind patterns occurring around site buildings during two seasons, summer and winter. This research subsequently focuses on the problems and potential design advantages, which are the basis of this structural design, in the interest of ventilation during summer and protection from low temperatures during the winter.

Summer winds

During the summer, south-westerly winds prevail at the site. The average prevailing wind speed is 2.18 m/s, which is strong enough to allow for sufficient ventilation.

In Fig.4.23, it is clearly illustrated how the summer winds create the flow patterns around the buildings. As a result, areas marked by yellow circles are the potential cool spots created from these high-speed summer winds.

Fig.4.21 Summer wind direction and speed

Fig.4.22 Higher speed wind occurs in void spaces

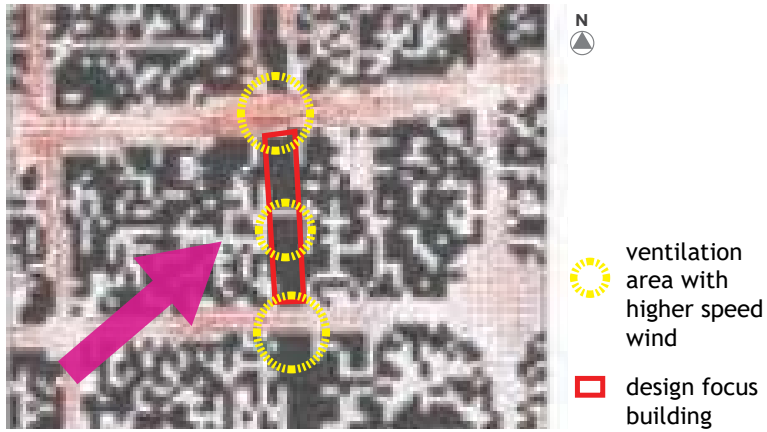
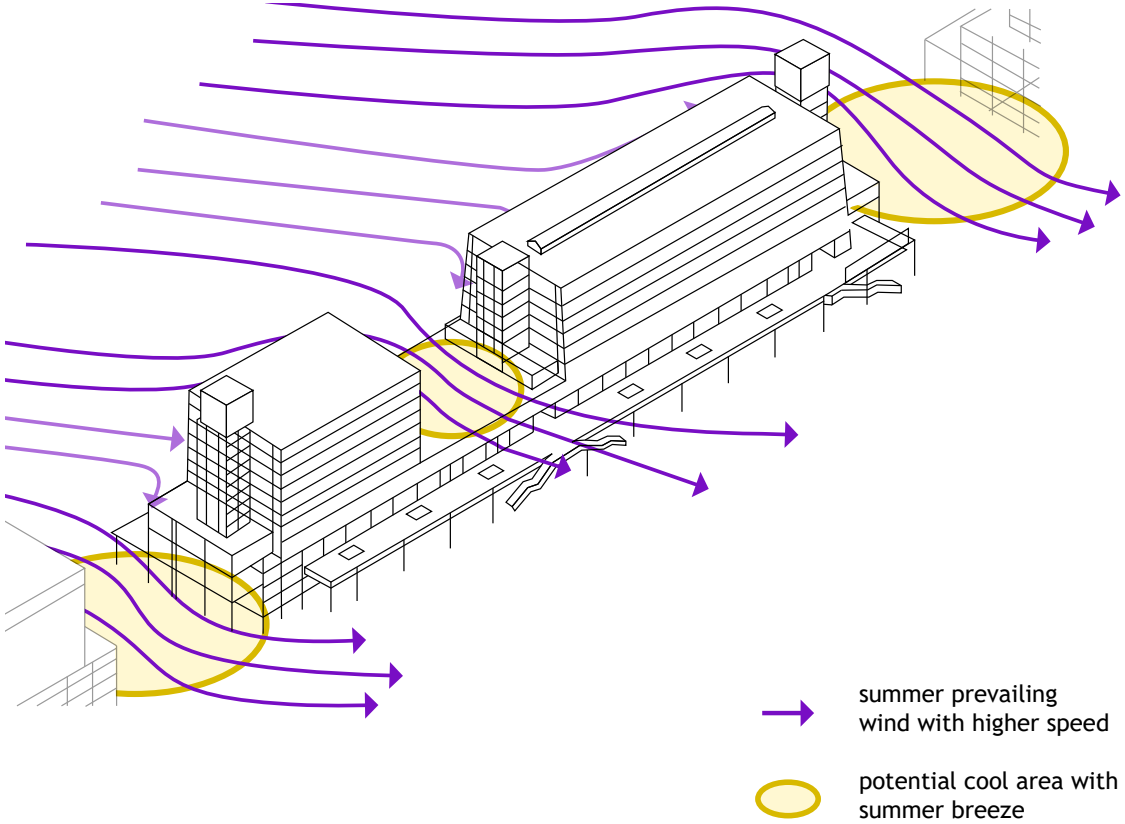


Fig.4.23 Conclusion on local summer wind pattern analysis

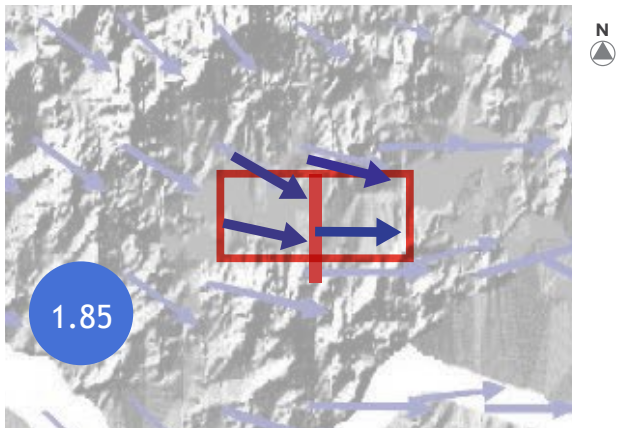


Winter winds

During the winter season, north-westerly winds are common, with an average speed of 1.85 m/s. (F.4.24) As drawn in Fig.4.25, there is a problematic spot for winter wind nuisance (marked with a red circle). This problem is present between the sides of large buildings as shown below, mainly as a result of the corner streams (i.e. the foot of high-rise buildings and the places where urban space narrows down). Therefore, some intervention is required in order to modify this problem.

On the other hand, as the yellow square indicates, wind-shades are also present behind buildings. Thus, these can be the potential spots for designing wind protection areas.

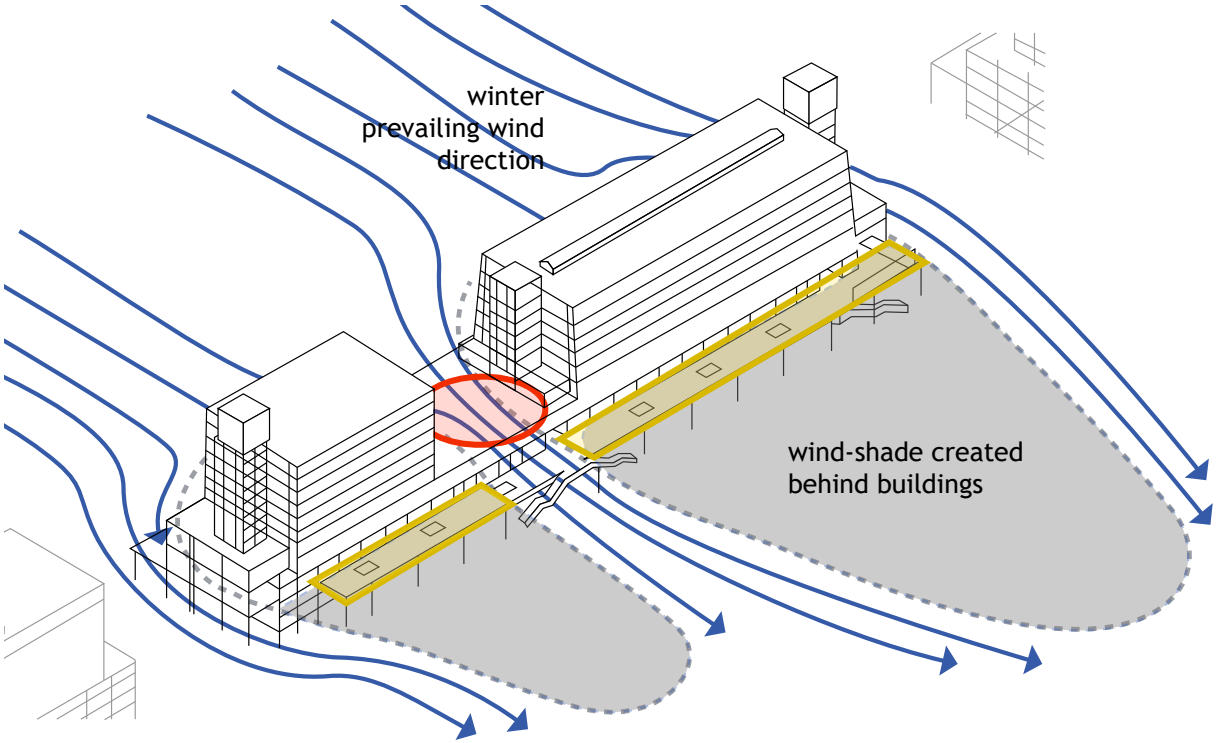
Fig.4.24 Winter wind direction and speed



problematic area from winter wind nuisance

potential for designing wind protection area

Fig.4.25 Local winter wind pattern analysis and conclusion



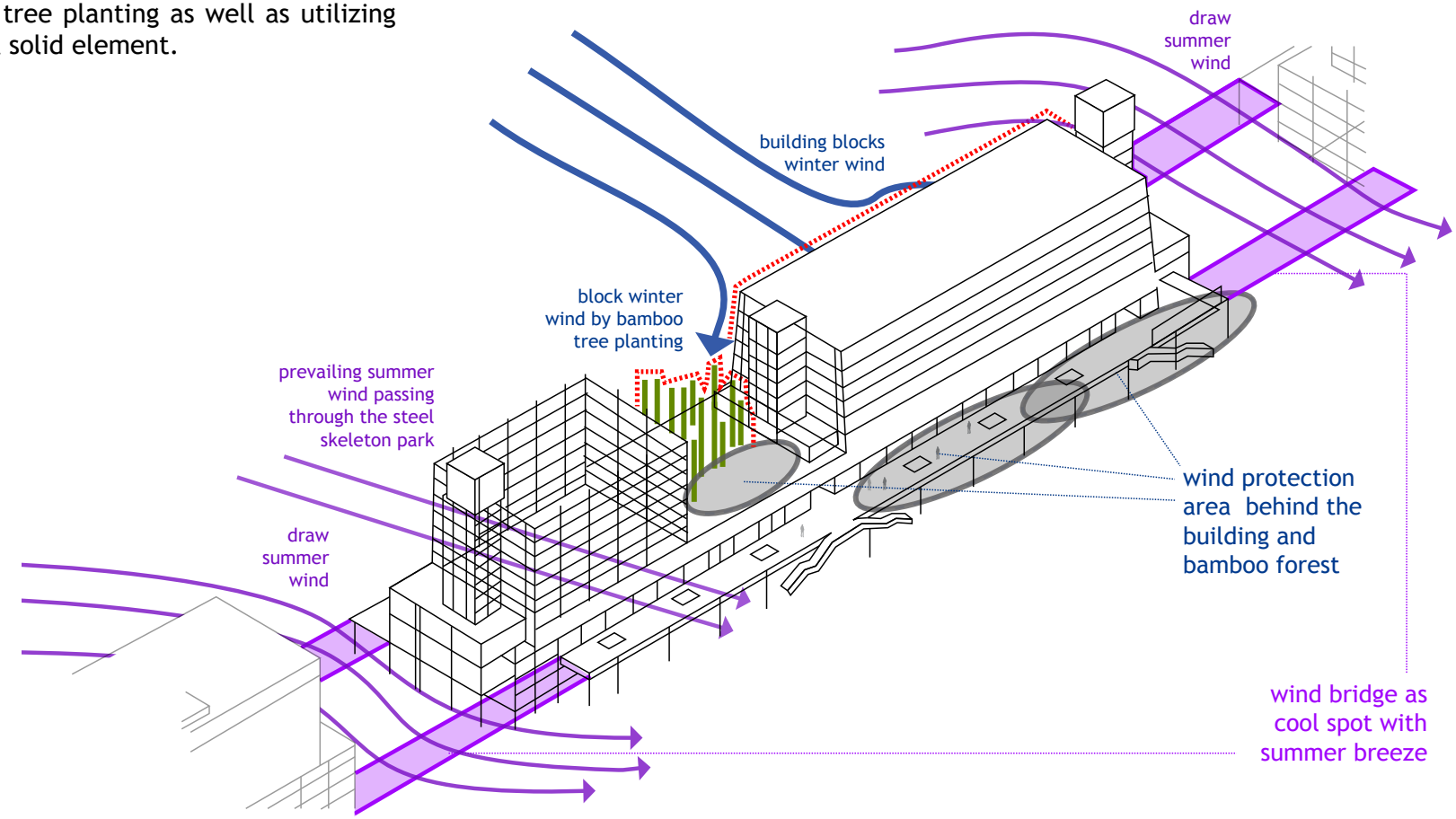
Design with prevailing wind patterns

Combining all these situations, the design proposal for wind experience is drawn in Fig.4.26.

For the case of summer, cool summer breeze will draw on the proposed pedestrian bridges (so that named as 'wind bridge') and the skeleton frame structure of the park will allow to pass the prevailing summer wind for ventilating effect.

For the winter situation, the design suggests to block the winter wind by bamboo tree planting as well as utilizing the existing building as a solid element.

Fig.4.26 Conclusion on local summer wind pattern analysis



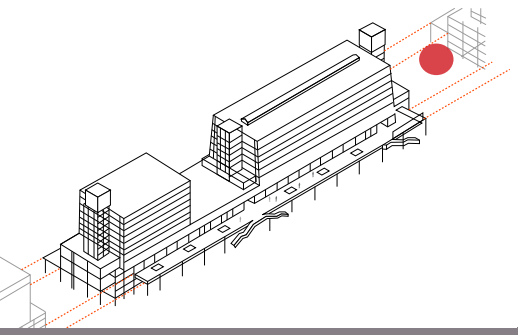


Fig.4.27 Impression B:

Wind Bridge Area

Impression B shows wind bridge area.
Wind indicating sculptures show the speed and direction of wind. During the summer, people can be realized the presence of the breeze and it cooling effect through the installations.
Colour code indicators also reveal the difference of temperatures depending on spaces and materials of the site.

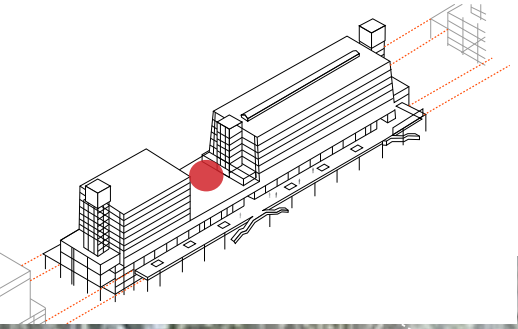


Fig.4.28 Impression C:

Bamboo Forest

Impression C shows the potential microclimate experience improvement by bamboo planting. In this bamboo forest area, people will be protected from cold wind nuisance, and will be still able to enjoy outdoor activities during the colder season.

4.3.3. Harvesting & using rainwater

Issues related to precipitation

Generally speaking, people perceive precipitation as a nuisance from which they want to be protected. However, for the case of hot summer days, people would feel pleasure in the cooling effect from rain showers. Therefore, these two influences from precipitation are considered as the problem and the positive potential to human's experience.

Also concerning precipitation, flooding risk from rainfall is one of the significant urban issues of this research's study area. Located at the centre of the Korean Peninsula, annual precipitation in the Seoul Metropolitan region ranges between 1100 and 1400 mm. About 50 to 60 percent of the annual rainfall occurs during the summer months - with nearly half of it during the monsoon (heavy rain) season - and usually lasts for one month, from late June until late July. Moreover, as it is shown in the statistical data from the Korean Meteorological Administration (Fig,4.30), the intensity of rainfall in the last 10 years has increased as a result of the rising incidence of heavy rainfall and other torrential rain events.

The project site has thereby particularly experienced frequent flooding in the past (refer to p.117 in the Appendix 3 for detailed information). As a response to these issues, the design in this study therefore proposes to construct a rainwater harvesting system within the vertical park structure, so that the system will control a peak runoff rainwater flow during the summer months, in addition to using the rainwater in economically savvy ways.

In what follows, the concept of rainwater harvesting systems is further explained.

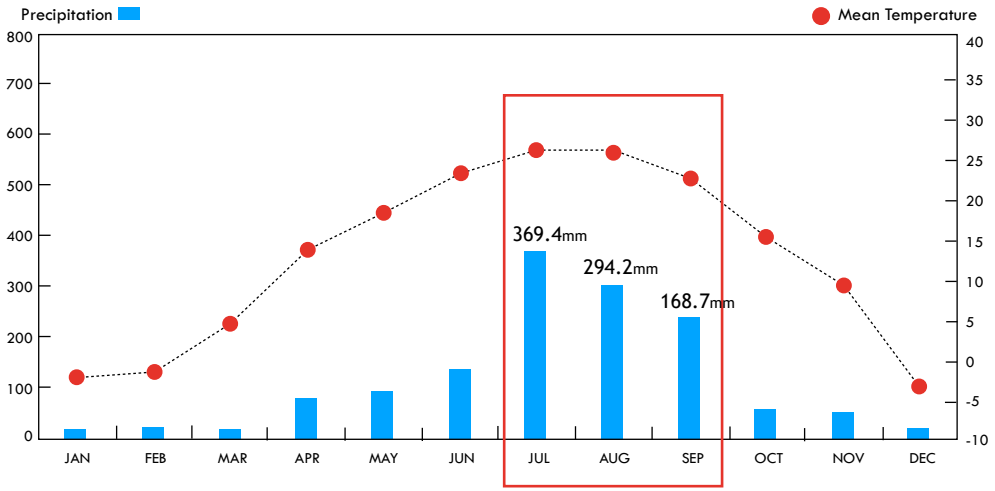
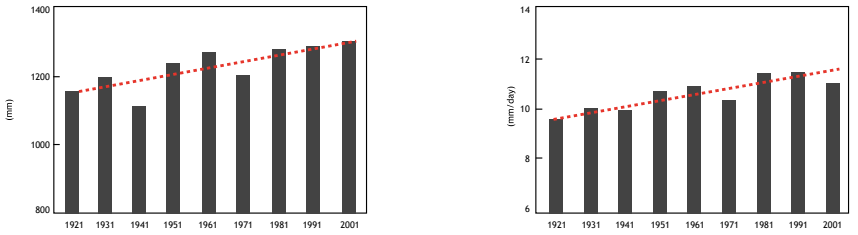


Fig.4.29 Monthly mean precipitation and mean temperature of Seoul

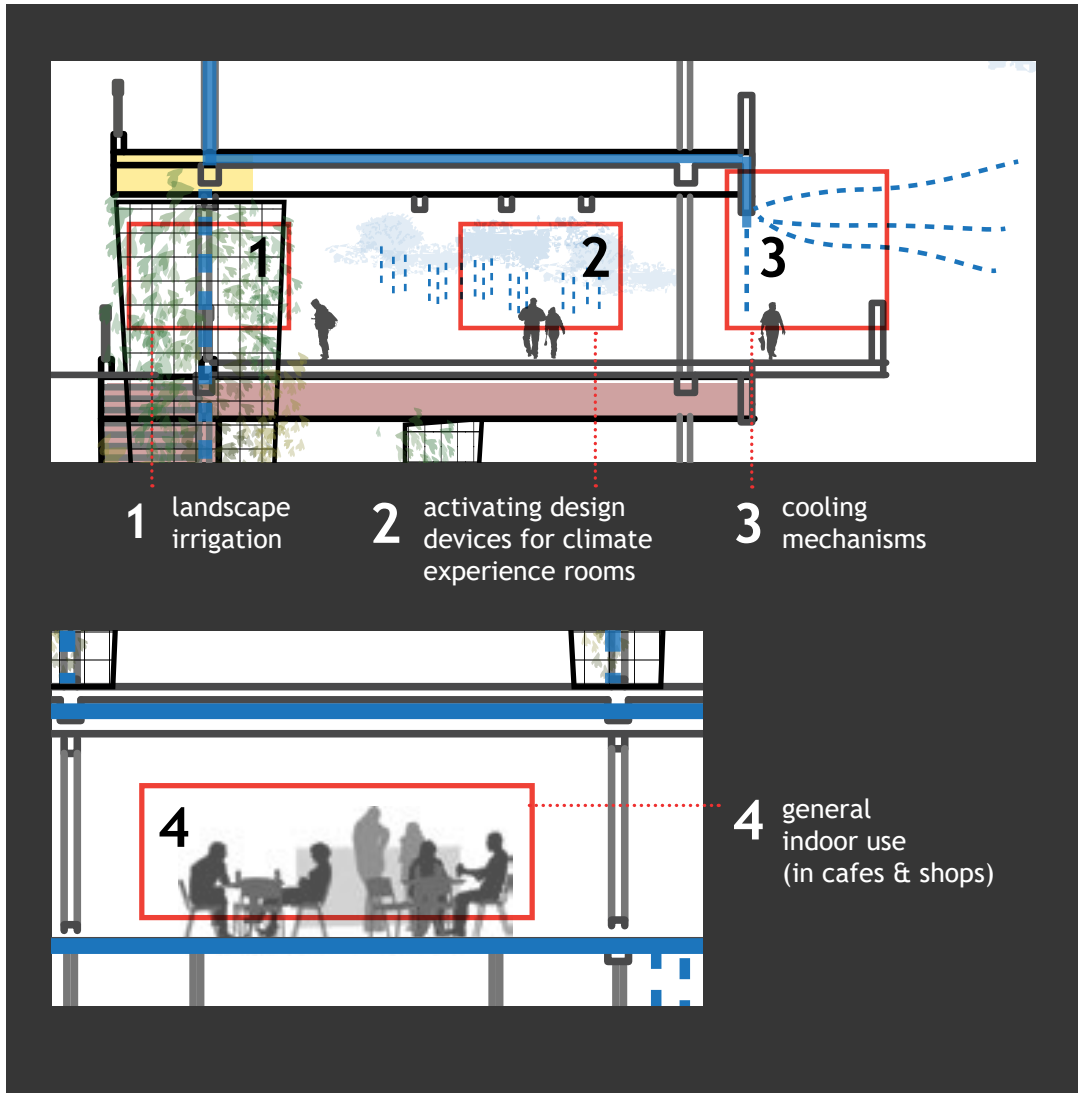


10 year average precipitation

10 year average rainfall intensity

Fig.4.30 Monthly mean precipitation and mean temperature of Seoul

Fig.4.31 Use of harvested rainwater

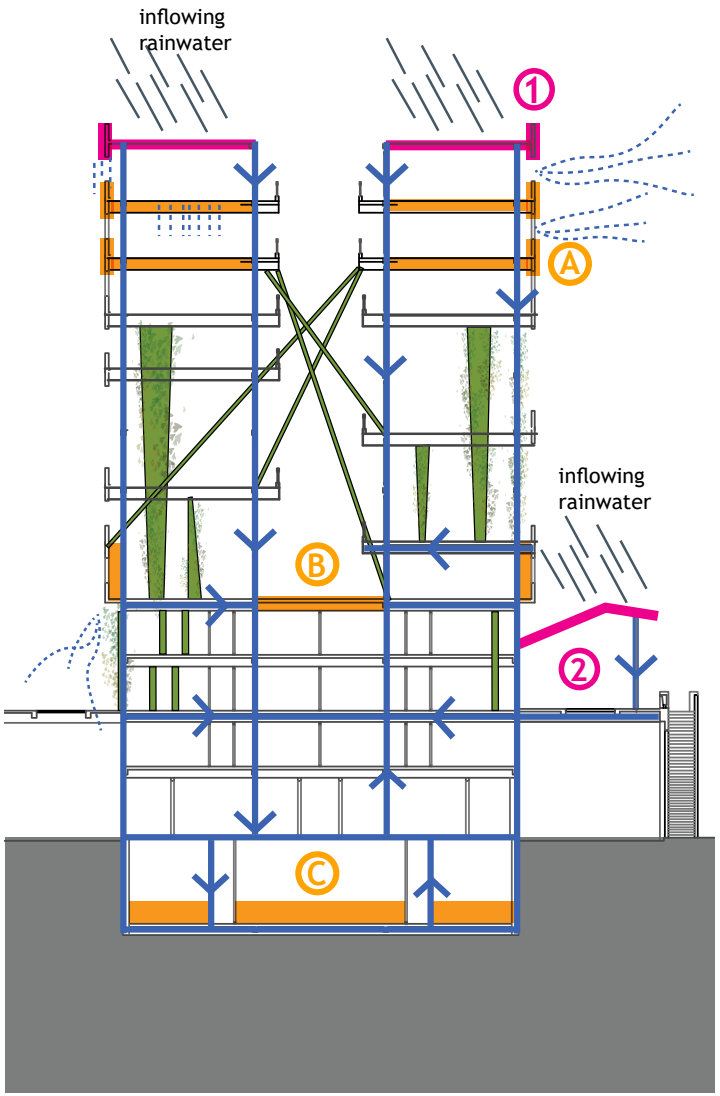


As shown in Fig.4.31, the harvested rainwater will be supplied into the park for four different purposes, including 1.) landscape irrigation (such as watering plants in the green climate atrium), 2.) activating design devices for climate experience rooms (such as generating climate effects of fog, cloud, and rain showers) 3.) cooling mechanisms (such as mist spraying during heat waves), and 4.) general indoor use (such as toilet flushing, washing dishes in cafes and shops).

In thinking of the way that the park uses rainwater, this study focuses on the amount requirements for collecting rainwater, and how to best use it for the broader park's system, equipment and maintenance involved.

Figure 4.32 in next page shows the system scheme of rainwater harvesting and distribution. The system's basic components are described henceforth.

Fig.4.32 scheme of rainwater storage and supply systems



① roof = 339.25m2

② weather protection glass canopy = 268.11m2

total catchment area = 663.36m2

- **Catchment area:**

This is the area that first captures the rainfall. The catchment area in this park consists of
1.) building roofs of 339.25 m2 and
2.) a weather protection glass canopy of 268.11 m2.

Conveyance system and water flow direction

- **Conveyance system:**

This refers to the way of moving the water from the catchment area to its storage area. In this park, pipes are the main conveyance equipment and they are installed within the park's concrete foundation.

storage tank location

Ⓐ small tank in terrace

Ⓑ middle size - slab

Ⓒ underground storage tank

- **Storage system:**

Three types of storage tanks are installed for future use in different locations throughout the park. First off, the small tanks are placed in the terraces. Located beside the climate experience rooms, the stored water in these tanks will be used for the climate experience and cooling devices.

The middle size tanks are then constructed under the structure's slabs and decks. Stored water in these tanks will therefore mainly be used for watering plants in the green atrium.

Lastly, the current underground parking area will be transformed into the main rainwater storage area where the biggest tanks are placed. Holding the significantly large amount 45.4 tons of rainwater, the underground tanks will keep supplying water for general indoor activities in cafes and shops.

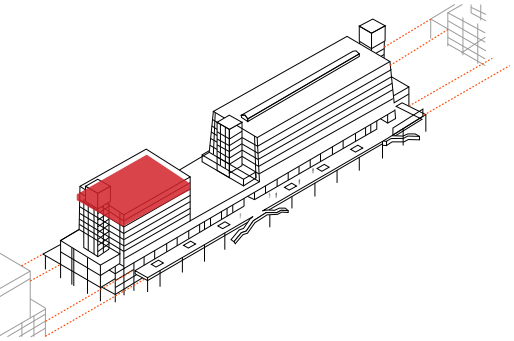


Fig.4.33 Impression D:

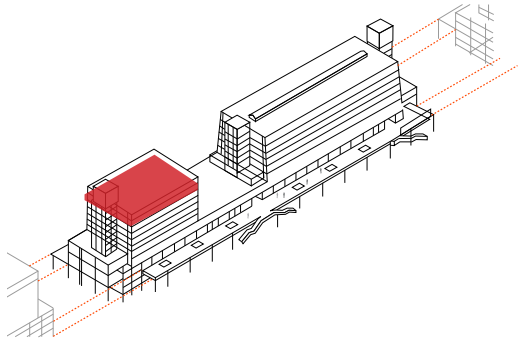
Climate Experience Rooms - Rain Room

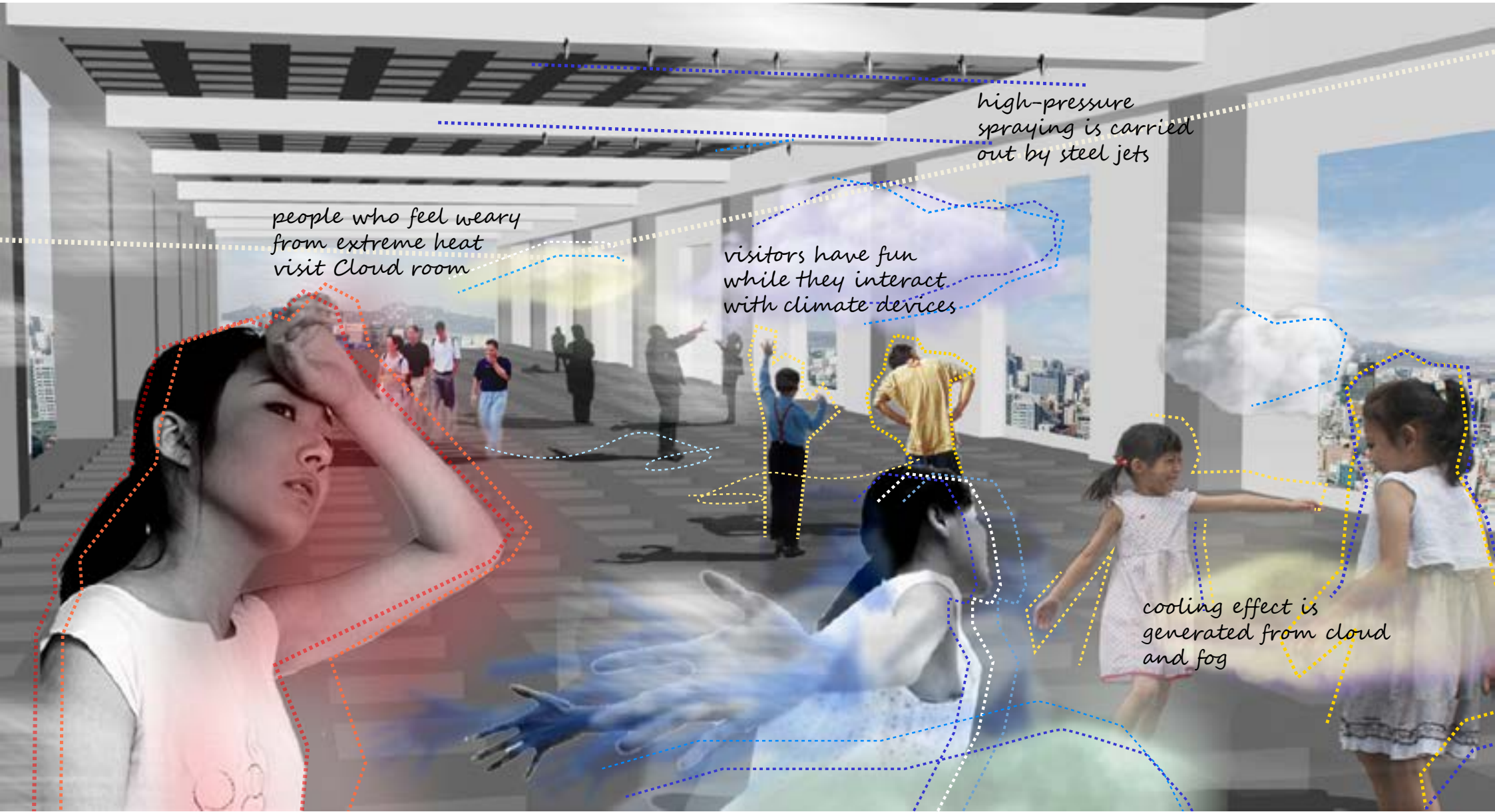
Impression D shows the rain room that use harvested rainwater for generating novel climate experience. In the rain room, the installed system with steel jets sprays innumerable tiny drops of harvested rain water to create rain shower effect. During the heat of summer, the rain room will be a popular space for visitors as a heat refuge.

Fig.4.34 Impression E:

Climate Experience Rooms - Cloud/Fog Room

Impression E shows how the original space in old building is transformed into cloud/fog room. In common with rain room, steel jets are controlled by computers to adjust the strength of the spray and to create the fog mass.
Visitors visually and physically learn about the short and long-term benefits of adaptation measures while they interact with enjoyable climate elements in this room.





Chapter 5

Conclusion

As the conclusion of the study, this final chapter will first summarise the study objectives and research questions, followed by the concluding results and addressing the significance of the research outcomes. Subsequently, critical reflection and recommendations for further research are discussed.

5.1. Review on study objectives

The global research team from Wageningen University's landscape architecture and land use planning group taken into account that adapting to local climates by way of urban planning and design has occurred worldwide. The group has likewise seen that there is the difference in adaptation capacity between countries and cities. As the part of the research structure, the author has sought

first 1.) to identify the current climate change adaptation capacities of South Korea

and second 2.) to create an exemplary design that makes climate adaptation more tangible and feasible for South Korean people.

5.1.1. Answers to research questions

For the first study objective, the main research question (RQ) is set as:

RQ. - "What is the current situation of urban climate adaptation in urban planning and design processes in South Korea?"

Chapter 3 has answered this main research question in analysing and concluding on the interview results. The answers are quickly reviewed below, following the following sub-research questions (SRQs).

Awareness and basic knowledge

SRQ.1 - What is the sense of urgency to adapting the urban environment to climate change in your city in the future, amongst citizens, politicians, planners, designers and urban climate experts?

SRQ.2 - How aware are the people involved in planning and designing processes of urban climate phenomena and climate adaptation measures?

The majority of cities in South Korea experience great warming effects due to urbanization, and all groups of people (citizens, politicians, urban planners, and designers) in South Korea have well recognized the phenomenon of UHI and its negative impacts. However, serious adaptation to urban climate issues tends to be neglected. Moreover, the knowledge on effective climate adaptation measures are not well known, and sometimes incorrectly understood among the South Korean people. As such, in order to highlight the urgency behind adaptation and raising awareness of urban climate measures, a focus on education fostering the interaction and active participation of pertinent stakeholders has been addressed as the most effective measure throughout this study.

Planning and design processes for implementation

SRQ.3 - Which urban climate adaptation strategies are used in the planning and design process and how successful are these strategies?

South Korea is lacking policy instruments for the implementation of impactful adaptation measures. Unsuccessful communication amongst different groups (particularly between politicians and urban planners/designers) seems to be a significant barrier to active preparation in climate adaption policies and planning. Given this lack of efficient communication, climate aware project commissions have not been as prevalent in policymaking, thereby limiting the opportunities to develop innovative design initiatives whose designs are climate aware.

SRQ.4 - Which concrete urban climate adaptation measures or interventions are used in urban climate adaptation strategies?

The variety of concrete adaptation measures is very limited in South Korea. Given that most citizens, politicians, planners, and designers are not fully aware of the real local climate problems, suitable measures for their situation are not successfully implemented and the need for them is not entirely acknowledged.

To conclude, the research results have highlighted that South Korea is lacking knowledge in using efficient climate adaptation measures in addition having limited communication strategies that help justify urban climate adaptation at the policymaking levels.

Taking into account the implications for a feasible design, the authors consider using climate responsive designs in order to raise awareness and inspire citizens and politicians, in addition to promoting their actions for concrete implementation. To test and prove this argument, an exemplary design is pushed forth, aiming to work in two different respects: by focusing on the ***'functional'*** and the ***'revelatory'*** aspects of the proposed project.

Therefore, the main design question (DQ) and sub-design questions (SDQs) were set as:

DQ. - "How can an exemplary design make climate adaptation more tangible and feasible for South Korean people?"

SDQ1. - In what ways can the design respond to the 'functional' issues of urban climate adaptation?

SDQ2. - In what ways can the design respond to the 'revelatory' issues of urban climate adaptation?

In order to answer these design questions, various climate devices are proposed with the two focus aspects, functional and revelatory. Throughout Chapter 4 – 'Research through designing' – the process of developing the design interventions are elaborately described, combining analysis on influential factors for climate experience with a theoretical framework on the need for these structural design innovations.

"Seeing is believing.", "If you can imagine it, you can achieve it." One of the simplest ways of getting people to imagine something is to create a picture of it (Sheppard, 2012, p.352).

The effects coming from those interventions are therefore communicated and confirmed by allowing for the visualisation of the designed devices and programmes. Through these visualised images, the author seeks to explain how the intervention can be applied in the pre-identified spaces and what kinds of climate experiences people will get while they interact with said designs.

Summarising and reflecting on the overall design, the diagram in Fig.5.1 (in next page 74) classifies the proposed design devices under the two different categories of functionality and its ability to be revelatory.

Through 'designing' in this study, it is found that functional effect of designs (e.g. evaporation effect from vegetation planting) focuses on enhancing urban climate comfort, while revelatory design devices (e.g. thermal colour indicators) work focusing on revealing the presence and effects of urban climate phenomenon.

Moreover, the design outcomes also confirm that many of the interventions fall under the common ground portion of the diagram.

The interventions in this common ground of functionality and ability to be revelatory are particularly important, because implementing this kind of designs can be a impactful solution to cities that have the same constraint of urban climate adaptation and communication. The author thereby interprets this potential as a greater variety of enjoyable climate devices that can be created, thus fulfilling both the purpose of functional and revelatory design.

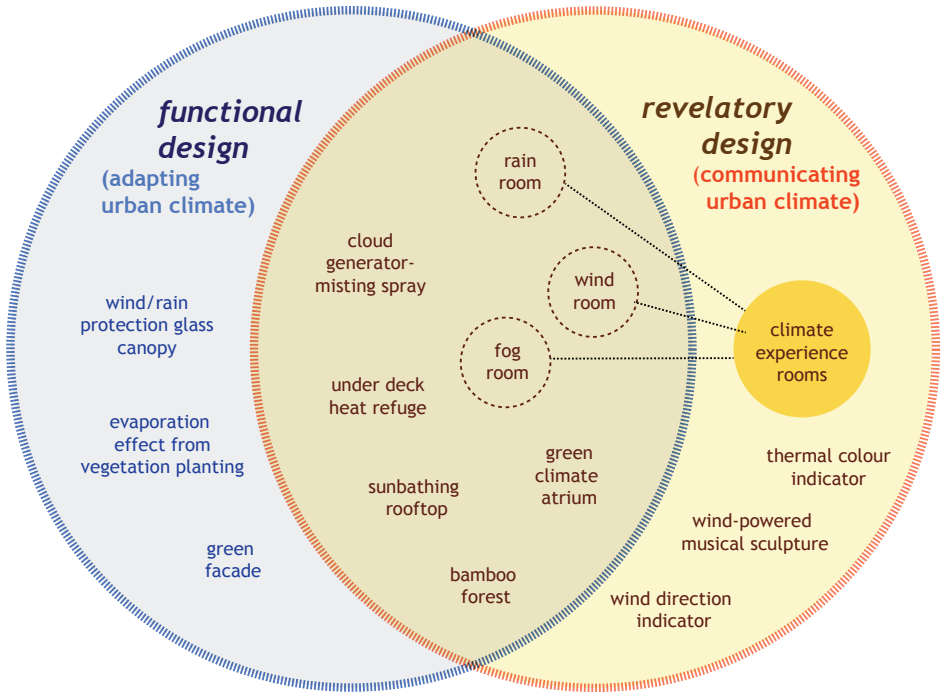


Fig.5.1 Reflecting on design; functional design vs revelatory design

5.1.2. Significance of study outcomes

Regional significance:

From the regional perspective, this study is significant given its contributions to identify the differences in urban climate adaptation capacity between different countries in regards to urban climate adaptation. Combining other students' studies of the international research group, reflective and comparative study outcomes are generated on urban climate adaptation at a global scale.

At a national level, this research has defined the climate adaptation issues of South Korea. First off, identification of urban and climate issues and realities of on the ground specific to the site in Seoul is generated. In doing so, this research was able to translate the local climate situation of the study site into the design language. As such, a location specific design has been produced in order to solve climate issues in the identified study location in South Korea.

Academic significance:

This research has sought to research the effective methods for communicating climate change, instead of following what previous research has already done, essentially only analysing the natural and physical science data on responding to climate change.

Despite these efforts from past research literature, there still is low awareness on adapting climate among those who do not accept the science of climate change. However, there is now a growing body of evidence that climate change scepticism is not really about climate science – it is about people's political viewpoints and worldviews,

which the science of climate change seems to challenge (Talking Climate, 2015). With this in mind, climate change communication is now at a starting stage, with this research helping to drive it forward.

Therefore, considering this present research from the academic research perspective, the study contributes to the design research and solutions dealing with both science of urban climate and people's perceptions and social behaviours on climate adaptation.

Landscape architectural significance:

The many suggested design interventions in this study have positively contributed to the microclimate, in addition to discussing the importance of urban renewal, the reuse of harvested rainwater and the structure's aesthetic value.

Although this study began by focusing on urban climate and people's microclimate experience, a holistic approach of understanding urban context was taken by the author in order to generate design solutions.
Therefore, this study's outcomes broaden the possibility of implementing climate responsive designs, along with their role in adapting and communicating climate change in the broader context of urban issues of interest. This is significant given the functionalities behind climate responsive designs, as previously discussed.

5.2. Critical reflection

In what follows, the general discussion points are highlighted, followed by a discussion on the performed methods and ensuing policy and design recommendations.

5.2.1. General discussion

Consideration on potential investors

As it has been addressed in the interview reviews in Chapter 3, one of the important barriers to implementing adaptation measures is financial constraint. This finding implies that it would be important to consider potential suitable investors. As a client of this proposed project, for instance, an investor is able to support the project financially while playing a key role in developing the project itself. Moreover, the project will tend to focus on fulfilling the interest of future investors. For example, if that investor is from the public sector or the government, the climate adaptation design will tend to focus more on creating public values to the urban society and living environment. However, if the future client is a health related organization or enterprise, the project would focus more on accentuating the beneficial effects that climate adaptation design can have on peoples' physical and mental health.

5.2.2. Discussion of the performed methods and recommendations

1.) Interviews and supporting literature

This study conducted interviews as the main method for studying and identifying the current situation of climate adaptation in South

Korea. It also reviewed academic literature supporting this study's interpretations of the South Korean people's perceptions on adaptive climate change in an urban context.

However, the majority of reviewed literature was written in European or North American countries. This can be a pitfall for exploring perceptions of South Korean people because of the incoherence of study methods not accounting for cultural and natural backgrounds of the specific study site of this research. Although this potential risk is recognized, the author had no choice but to conduct the study relying on available literature from abroad, given that the study and literature on people's perception on climate change specific to South Korea is too limited.

2.) Influential factors for the microclimate experience

In this study, the main focus for design has only been on physical factors of climate, such as solar radiation, wind and precipitation.

However, for the influential factors on the way people experience the microclimate designs, psychological factors are also important and should not be ignored. Some designed spaces and programs were created for certain thermal environments, such as 'warm' or 'cool', but this was also designed only from the physical aspects of climate adaptation-related literature.

Therefore, designing 'ambiance' by considering psychological aspects can be better elaborated in both analysis and design. As examples for psychological influential factors, spatial configuration, materials and colours serve as valuable initial suggestions.

3.) Bottom-up design approach

Yet another issue to discuss in carrying out the methodology for design is adopting a bottom-up approach for climate experience design. This approach seems to stimulate fresh discussion and reveal new directions for climate change communication. Human climate experience was one of the main focus of design. Owing to the constraints of limited study time, however, the study could not take the participatory method at the developing stage of the design. It was likewise difficult to obtain potential visitors and user opinions on the design.

If further research action focuses on this kind of interactive methods, the effects of design on communication for climate adaptation will be stronger and more reliable.

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- Fig.4.34 visualisation made by author

- Fig.5.1 diagram made by author

Appendix

Appendix 1: interview questionnaire

Urban Climate Adaptation Interview Questions

2014/2/24

General Information

1. Name:
2. City:
3. Position: ☐ Politician ☐ Urban planners/ designer ☐ Urban climate expert ☐ Other:____
4. Organization:
5. Email:

Awareness

1. What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?

Groups	Very urgent	Urgent	Neutral	Less urgent	Not urgent	Don't know
Citizens						
Politicians						
Urban planners& designers						
Urban climate experts						

2. In case the sense of urgency is low, what is needed to make those groups feel more urgent about adapting the urban environment?

Groups	Measures to sense of urgency
Citizens	
Politicians	
Urban planners& designers	
Urban climate experts	

3. How aware are the groups of the following two urban climate phenomena?
   - Urban Heat Island

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

   - Wind Discomfortability

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						

4. In case awareness is low, what is needed to increase the awareness among those groups of two urban climate phenomena mentioned in question 3?

Groups	Measures to increase awareness
Citizens	
Politicians	
Urban planners& designers	

5. How aware are the groups of following four urban climate adaptation measures?
   - City design (e.g. street orientation, adapting to wind and solar orientation of building and streets)

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners& designers						
Urban climate experts						

- Urban vegetation (e.g. green roofs, urban forestry)

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners& designers						
Urban climate experts						

- Use of materials (e.g. low albedo and longer cooling time-lag materials)

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners& designers						
Urban climate experts						

- Anthropogenic heat (e.g. less air conditioners)

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens						
Politicians						
Urban planners & designers						
Urban climate experts						

6. In case awareness is low, what is needed to increase the awareness among those groups of four urban climate adaptation measures mentioned in question 5?

Groups	Measures to increase awareness
Citizens	
Politicians	
Urban planners & designers	

Planning and design processes for implementation

Communication

1. Which roles do citizens, politicians, planners and designers and urban climate experts have in the process of planning, designing and implementing urban climate adaptation measures?
   Citizens:
   Politicians:
   Urban planners and designers:
   Urban climate experts:

2. What are the relationships between these actors in the communication strategies?
   Citizens/ Politicians
   Citizens/ Urban planners and designers
   Citizens/ Urban climate experts
   Politicians/ Urban planners and designers
   Politicians/ Urban climate experts
   Urban planners and designers / urban climate experts
3. What is the role of communication to support the planning, design and implementation of adaptation measures?

4. Are there formal guidelines or policies that drive the use of communication in the planning, design and implementation of adaptation measures?
   If yes, can you please name them?
5. What are the strengths and weaknesses of the communication process?

6. Is there need to improve the communication process?

   If yes, how to improve ?

Instruments

1. Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures?

   If yes, please explain how they work?

2. What are the strengths and weaknesses of the legally binding instruments used?

3. Are there certain chances / potentials missed when using the legally binding mentioned instruments (e.g. coupling with other instruments)?

4. Are there other policy instruments used to implement urban climate adaptation measures?

If yes, please explain how they work?

5. What are the strengths and weaknesses of the other policy instruments used?

6. Are there certain chances/ potentials missed when using other policy instruments (e.g. coupling with other policies)?

Implementation

1. Which concrete urban climate adaptation measures/ interventions are currently implementing or have been implemented in your city?

2. What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

3. Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

4. Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

5. Are there certain chances/ potentials (e.g. coupling with other interventions / 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

Thank you for answering the questions in this questionnaire. Do you have any other remarks regarding the urban climate adaptation process or the content of the questionnaire?

Appendix 2 - interview transcript

Awareness

1. **What is the sense of urgency to adapt the urban environment to climate change amongst the following groups in the future in your city?**

Seoul: √-Seoul metropolitan city government /◆-Landscape designers, office PARKKIM/ ○-Chul Kong, architect, urban designer/ ✣-Kiho Kim, Climate expert, researcher
Suwon: ◈-Suwon city government / ⌂-Politician, member of Suwon city council
Daegu: ✖-Daegu city government, planning department/ ✱-Climate expert, professor of Keimyung University/ ▲-Climate expert, Noa disaster prevention consulting company

Groups	Very urgent	Urgent	Neutral	Less urgent	Not urgent	Don't know
Citizens		√/✣/◈/⌂/✱	◆/✖/▲		○	
Politicians	⌂	√/✣/◈/✱	◆/✖/▲	○		
Urban planners & designers		√/◈/⌂/✖	◆/✣/✱/▲	○		
Urban climate experts		√/◆/○/⌂/✖/✱ /▲	✣/◈			

√-Seoul metropolitan city government: Because of the lots of effort that Seoul city government made for raising awareness, citizens are highly aware of the urgency of urban climate change. According to Korean Ministry of Environment, official research record shows that more than 86% of citizens showed their awareness of world and urban climate change, 59.8% of citizens answered that they recognize the need to adapt, and 40.4% of people responded that they have knowledge on adaptation measures. We are aiming to increase this percentage by offering more educative opportunities.

○-Chul Kong, architect, urban designer: The word 'climate change' is appearing everywhere in our society. In particular mostly people hear and encounter the issue of climate change from mass-media. However, in my honest opinion, they do not take serious consideration on it in their daily life. I saw this resulted from the lack of philosophical consideration amongpeople. They are fine to survive yet and too busy to think about what they do not get direct harms at every moments. Climate is an invisible thing. But we invented temperature. 'Degree' is the quantification of invisible thermal sense. People often talk about education as a measure for raising people's concerns in climate change. But, we should carefully reflect on the way that we are taking to educate citizens. They would get start to take the real considerations on climate issues when they actually get personal and serious experience on it. (This is a combined answer for question 1 and 2)

◈-Suwon city government: In Suwon city government, climate change response is the main policy domain. To build and develop new policies, all of related disciplines work under the issue of 'climate change'. It is a bit hard to make distinctions amongst the groups, I would say all of the peoplegroups are aware and the sense of urgency is high. I suppose it is also possible that climate experts could fill less urgent on urban climate change than we expect because they may trust their climatic knowledge to make current problems better. But this is just my opinion.

2. In case the sense of urgency is low, what is needed to make those groups feel more urgent about adapting the urban environment?

V-Seoul metropolitan city government: The sense of urgency differs from person to person, depending on their education background or age. We provided various types of educating events and publications to school for the youth. For the elderly who are the most vulnerable to urban climate change, health care services combined with educative information have been offered. I believe this helped a lot to raise public awareness indifferent people groups. Mayor and politicians such as the members of Seoul city council are highly aware of the urgency of climate change. In April of this year, we havehosted the global climate meeting, ICLEI(Local Governments for Sustainability). This kind of international conferences on urban climate issues have a strong effect on promoting political leaders' awareness as well as public awareness. Leaders from all over the world will show and share city's knowledge and experience, therefore participating in international climate conferences and other forms of international engagement can be good opportunities for both leaders and public. Offering education programs to planners and designer can increase their climate knowledge and adaptation measures. This should not be done in once, but should be offered on a more regular basis. Climate experts are fully aware of its urgency, because it is related to their profession, it is their job.

◆-Landscape designers, office PARRKIM: Public awareness always can raise when it links to their personal and practical concerns such as, health impact. Through advocacy campaigns, publications, and multimedia products, their sense of urgency can grow with the personal concerns in the direct impacts on individuals. Politicians would be more serious on the urgency when it is link to their election activities and results. If applicable climatic technologies for design solutions are developed, it would also help to get actual attentions from urban planners and designers on the urgency of climate aspects.

◈-Suwon city government: Citizens can be aware of the urgency of climate change when they actually get practical and personal experiences. To increase people's awareness, Suwon municipalityhastried to offer citizens educative experiences through some events, festivals. In the first day of September 2013, Suwon held a spectacular opening ceremony, EcoMobility World Festival, in essence car-free month. The people in the Suwon neighborhood of Haengung-dong were involved in the planning and implementation of the ecomobility concept. I believe this kind of events are

very effective to let peopleexperience a sustainable lifestyle in reality. Suwon citizens were able to reflect upon the reason why we need to pursue the sustainable lifestyle in our cities, and their sense of urgency in climate change have effectively grown through the experience in this event. I believe politicians are responsible in communicating with public and listening their experience. When political leaders understand to what extend their citizens have problems from urban climate change, their sense of urgency also grows. Linking to the educative events and festivals that I mentioned as a measure for growing citizens' awareness, the sense of urgency amongst politicians also can grow through such events. Innovative minds, committed leaders in EcoMobility and sustainable cities cameall together at the EcoMobility 2013 congress in Suwon. During this day, political leaders discussed and demonstrated the importance of creating cities and spaces with regard to climate change issues.

For urban planners& designers, they should try to expand their interests in climate aspects even though they are not familiar with that yet. They should pay attention what is happening in our society, and share their academic, professional, practical experience and opinions on urban climate with others groups of people. This is the way for educating and motivating themselves.

▲-Woobae Sim, climate expert, professor of Keimyung University: For citizens, this is the matter ofcommonsense lessons. I believe climate crisis is related to education crisis.For urban planners and designers, they need higher level education such as seminars or training courses. Evening extra education, free study course would help them to get profession knowledge. For politicians, when they made effortsto communicate with citizens, their awareness will increase. They will be promoted by people's voice.

3. How aware are the groups of the following two urban climate phenomena?

- **Urban Heat Island**

  Seoul: √-Seoul metropolitan city government / ◆-Landscape designers, office PARKKIM/ ○-Chul Kong, architect, urban designer/ ✧-Kiho Kim, Climate expert, researcher

  Suwon: ✧-Suwon city government / ⌓-Politician, member of Suwon city council

  Daegu: ✖-Daegu city government, planning department / ✱-Climate expert, professor of Keimyung University/ ▲-Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		√/◆/○/✧/	✧			

3

		⌂/✖/✱/▲				
Politicians	√/✖	◆/○/✧/◈ /⌂✱/▲				
Urban planners & designers	√/◆/○/✧/ ◈/✖/▲	⌂/✱				

√-Seoul metropolitan city government: Because Seoul has struggled with lots of negative problems derived from extreme heat waves every summer for several decades, I believe all groups of people of Seoul are highly aware of Urban Heat Island phenomena. Especially In 1994, Korea experienced extreme heat waves, and Seoul got huge and exceptional mortality impacts. After this extreme experience of heat wave occurred in July and August 1994, Seoul started to prepare disaster prevention measures from heat waves.

⌂-Politician, member of Suwon city council: Because the majority of cities in South Korea show great warming due to urbanization, I suppose all of the cities have highly recognized the phenomenon of UHI and its impacts, and Suwon is not exceptional.

✖-Daegu city government, planning department: Daegu is the one of thecities with highest vulnerability to heat waves. Being the southern part of Korea, the average temperature of Daegu is always higher than other cities, therefore heat waves phenomenon is more frequently considered than other cities. The environmental research team in Keimyung University of Daegu conducted a spatial vulnerability analysis of urban populations during extreme heat events several years ago.

- **Wind Discomfortability**

  Seoul: √-Seoul metropolitan city government / ◆-Landscape designers, office PARKKIM/ ○-Chul Kong, architect, urban designer/ ✧-Kiho Kim, Climate expert, researcher

  Suwon: ◈-Suwon city government / ⌂-Politician, member of Suwon city council

  Daegu: ✖-Daegu city government, planning department/ ✱-Climate expert, professor of Keimyung University/ ▲-Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		◆	✱/▲	√/○/✧/ ◈/⌂/✖		
Politicians		◆/◈/⌂/✱	√/✧/✖	○		

		/▲				
Urban planners & designers		◆/⌂/✖/✱ /▲	√/○/✧/✧			

√-Seoul metropolitan city government: Wind discomfortability is obviously considerable in Seoul because Seoul is a city with high buildings in every districts, however, the awareness in Wind discomfortability is relatively low as a specific climatic phenomenon. I suppose because people have perception that they do not need to suffer for long from wind discomfortability compare to UHI, its possible long-term risks have been often underestimated by public and mass-media.

⌂-Politician, member of Suwon city council: For wind discomfortability, there is little awareness amongst citizen. Suwon city mayor, politicians, planners are planning to develop wind corridor in Suwon for generating good condition wind.

▲-Woobae Sim, climate expert, professor of Keimyung University: Air pollution in Daegu has been a serious problem since several decades ago. To solve the significant problem of air pollution in Daegu, Keimyung University research team and Daegu city municipality has conducted a number of researches with the two study keywords; air and wind. For example, the current air ventilation system in Daegu has reviewed to develop wind corridors in the city. Issuing articles in newspapers and web-portals, the citizens' awareness in urban climate issues and phenomenon has grown.

4. In case awareness is low, what is needed to increase the awareness among those groups of two urban climate phenomena mentioned in question 3?

√-Seoul metropolitan city government:Awareness differs from individuals to individuals depending on their educational level and background. For young people like students, environmental education in school is the main measure for raising awareness in climate phenomenon.

○-Chul Kong, architect, urban designer:For citizens, I don't think it is particularly important to increase the awareness of two urban climate phenomena. Maybe urban heat stress should be informed to them linked to impact on health, but I don't see the urgency in the need of raising awareness of wind disturbance. But for politicians, urban designers and planners, educations is needed to prevent future disasters or risks.

◆-Landscape designers, officePARRKIM:Politicians would become serious on the urgency when it is related to their political activities and election results. I cannot think of any clear example measure for raising politicians' awareness at this moment, anyway possible measures could be considered link to this fact. More project opportunities are required to raise designers' awareness in their possible roles and abilities for climate responsive design. If more project opportunities are given to designers, for example, design competition with focus objective of creating

comfortable climate, that would be chances to educate designers and enhance their professional concerns and knowledge on urban climate aspects.

❖-Suwon city government: Sharing practical experience and commonsense on climate change is the measure for citizens. Listening attentively what people are experiencing and what they are struggling from urban climate phenomenon. I am not sure how urban planners& designers are aware of climate phenomenon but I would say sharing practical experience among different groups of people is important.

✱-Climate expert, professor of Keimyung University: As I recognized, the awareness of urban climate phenomenon is high amongst politicians in Daegu. Cooperation is required between urban planners, designers and climate experts / researchers. The research interest and capacity in Daegu is strong but the linkage to the planning is missed.

▲-Woobae Sim, climate expert, professor of Keimyung University: For citizens education is important. Politicians are aware of certain issues when it is really problematic in their city. Urban heat stress and air pollution is the key concerns of Daegu, and they have great interest in their political activities. As I mentioned before, issuing articles in local newspapers and web-portals, is helping to increase public and local awareness.

5. How aware are the groups of following four urban climate adaptation measures?

- **City design (e.g. street orientation, adapting to wind and solar orientation of building and streets)**

  Seoul: √-Seoul metropolitan city government / ◆-Landscape designers, office PARKKIM/ ○-Chul Kong, architect, urban designer/ ❖Kiho Kim, Climate expert, researcher

  Suwon: ❖-Suwon city government / ⌂-Politician, member of Suwon city council

  Daegu: ✖-Daegu city government, planning department/ ✱-Climate expert, professor of Keimyung University/ ▲-Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens			❖/⌂	√/◆/○/❖ ✖/✱	▲	
Politicians		◆/○/❖/⌂/ ✱	√/❖/✖/▲			
Urban planners& designers	√/❖/⌂/✖/ ✱	◆/○/❖/▲				
Urban climate experts	❖/✱	√/◆/○/❖				

		⌂/✖/▲				

√-Seoul metropolitan city government: As I mentioned in the beginning, the awareness in the urgency of climate change is high among people, but awareness in adaptation measures (especially amongst layman such as citizens) is low. Especially, the measures in building sectors (as suggested in this categories), only groups who from related professions are aware well of its importance for urban climate adaptation.

O-Chul Kong, architect, urban designer: Planners and designers have started to become aware of adaptation measures (especially planners who belong to government organizations), but I suppose there are only very few people who are actually working for implementing adaptation measures in practice. This implies the good awareness does not necessarily convert to proactive environmental actions.

- **Urban vegetation (e.g. green roofs, urban forestry)**

Seoul: √-Seoul metropolitan city government / ◆-Landscape designers, office PARKKIM/ O-Chul Kong, architect, urban designer/ ✧-Kiho Kim, Climate expert, researcher
Suwon: ◈-Suwon city government / ⌂-Politician, member of Suwon city council
Daegu: ✖-Daegu city government, planning department/ ✱-Climate expert, professor of Keimyung University/ ▲-Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		✧/⌂/✱	√/◆/O/◈/ ✖/▲			
Politicians		√/O/✧/◈/ ⌂/✖/✱	◆/▲			
Urban planners& designers	√/✧/◈/⌂/ ✖/✱	◆/O/▲				
Urban climate experts	√/✧/◈/⌂/ ✖/✱/▲	◆/O				

◈-Suwon city government: Urban greenery is the most concrete and common measure in use at present. As you can see in the Suwon climate adaptation plan document, there is a growing concern in increasing the amount of vegetation and green space. In particular we have a particular interest in increasing green roofs and land for agriculture in the city.

✖-Daegu city government, planning department: Special emphasis is attached to implementing green roofs on existing buildings, with the awareness of its benefit for cooling city's temperature down. However, the lack of financial support is the barrier to implementation.Daegu city government has a plan for supporting financial funds to build green roofs on the commercial buildings. The maximum percentage for support is 50~80% of building cost for green roofs until 2018.

✱-Climate expert, professor of Keimyung University: In Daegu, awareness of urban vegetation as a measure for heat stress is quite high amongst all groups of people. But it has not been yet considered with any concrete implementing systems to build. I think national and local level governments should take some leading actions for this.

- **Use of materials (e.g. low albedo and longer cooling time-lag materials)**

Seoul: √- Seoul metropolitan city government / ◆- Landscape designers, office PARRKIM/ ✪- Chul Kong, architect, urban designer/ ✧- Kiho Kim, Climate expert, researcher
Suwon: ◈- Suwon city government / ⌂- Politician, member of Suwon city council
Daegu: ✖- Daegu city government, planning department/ ✱- Climate expert, professor of Keimyung University/ ▲- Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens			◆/✧	√/✪/✖	◈/⌂/✱/▲	
Politicians		✧/✖	◆/⌂/✱	√/✪/◈/▲		
Urban planners& designers	✪/✧/⌂/✱	√/◆/◈/✖/▲				
Urban climate experts	√/✧/◈/⌂/✖/✱/▲	◆/✪				

✪-Chul Kong, architect, urban designer: Asphalt is an awesome material for storing the sun's heat. Seoul is the city taken over by large amounts of cars. You can easily find asphalt traffic roads that have multiple lanes going in the same direction. (four to eight, even sometimes 16 lanes road exists in Seoul.) This is very problematic to heat stress in Seoul. But, Cheong GyeCheon Stream Restoration can be seen as a good success that Seoul made. The project is transformation of a site with more than a 5 mile long concrete roadway with an elevated highway into a vibrant public recreation open space running that serves the old central business district area of Seoul. Some research results have proved this project helps

reduce urban heat island effect in Seoul. Awareness of people in use of materials in artificial building structures would raise through this kind of success story of public projects.

✱- Climate expert, professor of Keimyung University: Daegu city government has a growing interest in dealing building materials for cooling urban heat. For example, there is a consideration in developing planning regulations of using light colored materials for buildings and traffic roads.

- **Anthropogenic heat (e.g. less air conditioners)**

  Seoul: √- Seoul metropolitan city government / ◆- Landscape designers, office PARRKIM/ ○- Chul Kong, architect, urban designer/ ✧- Kiho Kim, Climate expert, researcher

  Suwon: ◈- Suwon city government / ⌂- Politician, member of Suwon city council

  Daegu: ✖- Daegu city government, planning department/ ✱- Climate expert, professor of Keimyung University/ ▲- Climate expert, Noa disaster prevention consulting company

Groups	Very aware	Aware	Neutral	Less aware	Not aware	Don't know
Citizens		√/✧/▲	◆/○/◈/⌂/ ✖/✱			
Politicians		√/○/✧/◈/ ⌂/✖/✱/▲	◆			
Urban planners& designers		√/◆/○	✧/◈/⌂/✱/ ▲	✖		
Urban climate experts	○/◈/✱/▲	√/◆/✧/⌂/ ✖				

6. **In case awareness is low, what is needed to increase the awareness among those groups of four urban climate adaptation measures mentioned in question 5?**

√-Seoul metropolitan city government: For citizens, I would say again education is the strongest measure.

◆-Landscape designers, office PARRKIM: Again, politicians would be more serious on the urgency when it is link to their election activities and results. Therefore some kind of linking bridge is required between two interests, climate adaptation and their political direction.For designers, we have experience in designing public space with climatic aspects and elements. When we promoted our proposal to the client, we found climate responsive design is a very new concept in South Korea. Because it is a new field, climatic aspects for design sometimes have a low estimation from people. Therefore if more project opportunities are offered to designers, they will learn a lot about related knowledge and measures through participating in the climatic design projects. In addition, I also see the need of the development in climatic technologies or concrete handy tools for design. This would be indeed strong means to increase awareness of adaptation measures among design professions.

O-Chul Kong, architect, urban designer: The adaptation measures mentioned in above questions are mostly related in architectural or environmental building and design sectors. I suppose laymen like ordinary citizens are not highly aware of those measures. To increase public awareness in this kind of professional measures, some links are needed to laymen. For example, it would be helpful to make a linkage between the use of adaptation measures and public's common interest such as the economic schemes for energy tax increase and cuts. For urban planners and designers could learn through seminars and training course or events.

◈-Suwon city government: There is a rapid increase in the numbers of people who see urban climate change as business opportunities. In the last few years, many businesses have started up with innovative ideas responded to climatic problems and issues. I have recognized that the awareness and concerns have grown rapidly, because people have started to see the opportunities to make money out of adaptation measures. Perhaps government could support in offering platforms or funding to develop this commercial potentials of climate adaptation measures.

✱-Haedong Kim, Climate expert, professor of Keimyung University: There is a great research interest in the urban spatial structure to adapt urban climate in Daegu. Various types of research investments are growing rapidly because of high awareness of the serious heat impact in the city. However the link is missed to the adaptation strategy in planning. Perhaps the lack of awareness in other groups, anda lack ofpolitical interest are the reason of this. This limited interests should be expanded to the other disciplines. This is urgently required.

▲-Woobae Sim, climate expert, professor of Keimyung University: To think of adaptation measures, especially in terms of the types in building

sectors, we perhaps could look back in the urban development history in South Korean cities. Basically in Korean tradition, designs for creating liveable urban climate have solid roots in practical precedents of traditional vernacular building typology and town layout planning. If we think of Fengshui, our ancestors gave efforts to build cities(towns/villages) and architectures to respond to nature and climate for survival. Fengshui is both philosophical and practical system of harmonizing everyone with the surrounding nature environment. However, this changed after the rapid urbanization and modernization occurred in earnest especially since the 1960s. Land and cities in South Korea caused environmental issues such as reckless development and degraded ecosystem due to the land policies with the focus on supply in order to cope with the growing population. Owing to this change in the rapid development trends, cities in South Korea have been incorporated of climate aspects in urban planning and design. I would suggest the contemporary interpretation of the past Korean building and planning tradition. Through understanding the difference between the Korean historic villages(cities) and the modern cities, we could get some clues for creative adaptation measures which also can enhance the characteristics and placeness of the city. Last year, I attend a conference meeting for climate adaptation, and gave a presentation about the change in material use in traditional ways such as stone pavements. This is an example measures that I mean.

Communication

1. Which roles do citizens, politicians, planners and designers and urban climate experts have in the process of planning, designing and implementing urban climate adaptation measures?

v-Seoul metropolitan city government: Citizens is the group who has to be the center of the process of communication. Citizens, the ordinary laymen, are the most vulnerable group to climate change. They should make strong voices to express their experience. Politicians should be the leaders in the process who listen citizen's voice and make policies for them. They always have to try to feel sympathy with citizens. Planners and designers are the group thatmake adaptation happens in real situation by concrete design solutions. Climate experts are the most important supporters with expert knowledge and information.

◆-Landscape designers, office PARRKIM:

Citizens: get direct impact on their daily life

Politicians: draw and offer good urban design and planning projects

Urban planners and designers: create public space trough participating in actual projects

Urban climate experts: help other groups of people through elaborated researches

◈-Suwon city government: In the communication process, the engagement of political leaders has several roles. First, they are responsible in leading the successful cooperation amongst all groups of people. Second, their engagement can motivate people's active participation in communication process, by suggesting political commitment. The planner and designers are the group who has spatial and architectural aspects and knowledge in the process of climate adaptation.When we think about the need of evidence-based adaptation approach in our policy plan, urban climate experts have the role for matching between the types of climate information and data availability, and meet the policy makers' needs.

⌂-Politician, member of Suwon city council: Political outcomes for climate change adaptation have been addressed a lot. The Mayor of Suwon is fully aware of political importance in climate change actions. Because he has a strong background in environment, (he has university education in environment science and he used to be an environmental activist before he became mayor), the political actions of Suwon has been directed under his concerns of green city and environment. Basically to think of environment is to think of citizens. Other groups such as planners, designer and climate experts should aim tosupportcitizens based on their professional abilities and sufficient knowledge, information.

✖-Daegu city government, planning department:
Citizens: get impacts on their daily life.
Politicians: have responsibility of decision making. and they sometimes have financial responsibility too.
Urban planners and designers: have responsibility of generating practical solutions or instruments
Urban climate experts: have responsibility of technical parts and knowledge.

2. What are the relationships between these actors in the communication strategies?

v-Seoul metropolitan city government: I think I have already explained the relationships when I addressedthe roles of different groupsin the process of planning, designing and implementing urban climate adaptation measures.

◆- Landscape designers, office PARRKIM: Politicians can offer planners and designers actual planning and design projects.Urban planners and designers are the group that has role of creating better cities trough participating in that urban planning and design projects. They need climate knowledge tocreate applicable design adaptation measures and solutions. For this, urban climate experts can help them by offering knowledge from their elaborated researches.

✱- Haedong Kim, Climate expert, professor of Keimyung University: Strategic coordination is important for prioritization of adaptation, multi-level coordination can improve implementation of adaptation by specifying the financial and technical responsibility of governments and actors.

3. What is the role of communication to support the planning, design and implementation of adaptation measures?

v-Seoul metropolitan city government: As I have already mentioned earlier, Seoul city has been aware of the importance of education to raise the public awareness of urban climate issues. Good communication can also have educating effect for all groups of people. Furthermore, high inspirations can be derived from good communication process, and people(from all of the groups) would be promoted to put what they have learned from the communication process into actual actions.

O-Chul Kong, architect, urban designer: The role of communication is to get agreements among different groups of people. The fundamental objective of communication is to make and sign a contract. The process of planning, designing and implementing urban climate adaptation measures is the process of finding common ground among different interests, and concerns.

◆- Landscape designers, office PARRKIM: The process of communication helps to generate ideal solutions and innovative ideas for adapting climate.

◈-Suwon city government: I suppose communication is the main method in the process of planning and implementing climate adaptation measures. The process of adapting urban climate change starts from communications and ends with communications. For example, to make the climate change response plans and policies, we first started with exploring on the extent of awareness of citizens. For this, communication was importantly required. Moreover, to make decisions for building policies, we communicated with people from other disciplines and other levels governments. Therefore, I would say communication is actually an entire thing for the whole process of policy and plan making.

⌂-Politician, member of Suwon city council: Suwon has fully recognized the importance of citizens engagement. We pursue a people centered city through projects like the citizen-driven Urban Planning. Communication is important for us to listen citizens voice and therefore we can achieve our aim of creating a people-oriented green city.

✱-Haedong Kim, Climate expert, professor of Keimyung University: For creating a climate-friendly city, the most important role of successful communication is to share information. This information includes problems, measures, and the knowledge for successful implications.

▲-Woobae Sim, climate expert, professor of Keimyung University: In the process of planning, designing and implementing adaptation measures, communication is a constant requirement throughout the whole process.

4. Are there formal guidelines or policies that drive the use of communication in the planning, design and implementation of adaptation measures?
If yes, can you please name them?

O-Chul Kong, architect, urban designer: I am not sure if any formal guidelines or polices exist. If there are some, perhaps not many of people know about it and more attention is required. Because I never heard about it.

◆Landscape designers, office PARRKIM: As I know, there are no certain formal guidelines or polices only for using communication.

◈-Suwon city government: Suwon does not have certain communication strategies with regards to urban climate adaptation

✱-Haedong Kim, Climate expert, professor of Keimyung University: I am not sure about this. I have not heard on any formal guidelines.

▲-Woobae Sim, climate expert, professor of Keimyung University: I don't think there are specific guidelines which only focused on using communication.

5. What are the strengths and weaknesses of the communication process?

◆- Landscape designers, office PARRKIM: The strength of successful communication is that new solutions can be generated during the communication. However, it only happens when the process has worked successfully. That is very hard in reality. The increase in the number of engaging people and disciplines also brings more conflicts because all different groups of people have different interest.

✱-Haedong Kim, Climate expert, professor of Keimyung University: Communication of climate change information basically aims to increase awareness/ education and understanding, provide continuity, during the engagement of policy-makers, stakeholders, and the public.

▲-Woobae Sim, climate expert, professor of Keimyung University: Good communication processes can offer a consulting platform for all groups of people. Because they are from different backgrounds, they would like to confirm what they thought through consulting from other field of experts. In particular, comprehensive consultation processes helps stakeholders to build adaptation capacity and generate consensus for implementing adaptation measures.
Giving an example of the weak process, communication can fail when people take negative attitude in participation. People often passively act when they are in discussions that they do not have enough experience and knowledge.

6. Is there need to improve the communication process?

If yes, how to improve ?

O-Chul Kong, architect, urban designer: Mostly communication is difficult and when it goes inefficiently participants can get stress. Different interests with positions may be the biggest barrier. People cannot easily agree because their interests conflict. To be honest, I do not think this barrier can fundamentally be improved, but people just should keep trying to find common grounds.

◆-Landscape designers, office PARRKIM: To improve communications in the process of planning, designing and implementing urban climate adaptation measures, all different people groups should expand their interestsin the other disciplines and fields too.They should give an effort for studying and exploring on other groups'professions that they have not been familiar with. If not, the communications would hard to be successful because of the lack of understanding of each others. Open minded attitude is required.

◈-Suwon city government: I think most of the communication progress that we have conducted were quite successful. Perhaps better coordination and cooperation between planners/designers and politicians/government is required for improvement.

✱- Haedong Kim, Climate expert, professor of Keimyung University: As I have addressed earlier, strong climate research interest has not continued to create concrete planning strategies in Daegu. This resulted from to the problematic communication process. Implementing climatic knowledge in planning process easily occurs conflicting interests, since planning is often read as a political activity which is not always based on or even related to scientific knowledge. In Daegu, there is an obvious lack of coordination between different professions and government departments. In particular, more effective and frequent communication is required between the climate experts and planners from government organizations.

▲-Woobae Sim, climate expert, professor of Keimyung University: I found that the science and scientists have often been central of the communication in the process of climate change adaptation. Most of people groups except climate experts might be not confident in their knowledge for climate and sometimes too much of focus stressed on climate experts in the communication process. Balance is needed. The most important thing is all groups' active participations to make a development in climate adaptation measures. Scientific knowledge is not sufficient to make real actions. When experts talk to other groups about the technical information for climate change and adaptation measures, very commonly that is in one-way communication. There is just little room for dialogue, building a shared understanding of the problem and suggesting possible solutions. I believe this is very problematic. To reach to the best solutions especially for some particular local situation, all groups of people should actively suggest their ideas for adopting measures. Most important of all, I do think the citizens itself must become the first concern.

Instruments

1. **Are there legally binding instruments (e.g. zoning plans) used to implement urban climate adaptation measures? If yes, please explain how they work?**

√- Seoul metropolitan city government: In May 2007, the National Committee on Climate Change Response chaired by Prime Minister decided to develop a 'National Comprehensive Plan for Climate Change Adaptation'. This policy setting of Korea has the vision of establishment of safe society and support for green growth through Climate Change Adaptation. Following this national level plan, national climate adaptation strategies and programs are also established.

Please refer to this policy document. As the Legal plan for adaptation, the Framework Act on Low Carbon, Green Growth made the Adaptation Master Plan with 13 related ministries, 86 Major Projects for 10 Sectors. 10 Sectors include 1.) Public Health, 2.) Disaster/Infrastructure, 3.) Agriculture, 4.) Forest, 5.) Marine/Fishery, 6.) Water, 7.) Ecosystem, 8.) Climate Change Monitoring and Projection, 9.) Adaptation Industry/Energy, and 10.) Publication Education International Cooperation.

❖-Kiho Kim, the director of research institute for Climate Change Response: In Seoul, basically the main way for adaptation has been promoted is by finding linkages to environmental planning. In pushing both climate mitigation and adaptation planning, national government and local environmental planning agencies have collaborated to create more green spaces, for example, by building greenways, city forests, and ecological parks on sites that were previously built-up areas. There are some regulations which require developers to set aside green space in new developments. This regulations can be understand as the planning instrument in the context of South Korea's climate adaptation efforts.

⌂-Politician, member of Suwon city council: Korea is the first country to produce a comprehensive national green growth strategy and Suwon is t he first city who started to make their entire policy plan under the theme of 'Climate Change Response'. This means all political systems of Suwon in response to climate change. For the present most concrete legally binding policy, I would say 'emission trading'.(Can you explain more on what is 'emission trading'?) Emissions trading is a legal limit on the quantity of a certain type of chemical an economy can emit each year. This is a mark et-based policy instrument used to control pollution by providing economic incentives. It aims to achieve reductions in the emissions of pollutants.

◈-Suwon city government: Suwon pursues an urban policy that is harmonious with the environment and focuses on community culture. To green the building sector, market-based measures such as grants, subsidies, tax cuts and credits are developed to encourage investment in energy-

efficient appliances and projects. In particular, we are planning to provide landlords and homeowners with incentives for implementing energy efficiency upgrades or offer direct subsidies to homeowners to install energy-efficient equipment, who are more likely than tenants to invest in energy-saving equipment.

In addition to current regulations that have recently been adopted, including reinforced building codes and the mandatory estimation of energy consumption, under national government framework, we are working to establish incentives (or disincentives) for regulating the energy consumption behavior of existing residences and look to increase consumer awareness of the benefits of green building through eco-friendly building certificates or energy efficiency grading instruments. Moreover, special attention was paid to integrating transportation and land use planning to achieve greener growth. A compact, transit-oriented development strategy could effectively underpin complementary market based measures, such as comprehensive road charging in cities and parking tariffs, adnoun-market-based interventions, such as energy efficiency labeling and more sustainable building codes.

✖-Daegu city government, planning department: As I know, none of legally binding instruments have been put in place in Daegu's land use planning and policy strategies with regards to climate adaptation. Maybe some regulations for environmental /green buildings can link to climate adaptation measures. In our planning department, we have key challenges to the implementation of green growth policies at the urban scale and proposes a series of recommendations for strengthening implementation. These are with a focus on policy instruments to green the urban transportation and building sectors.

✱- Haedong Kim, Climate expert, professor of Keimyung University: In my experience, I have found that using climate knowledge in the planning process is indeed new concepts. Perhaps there is no legal binding policy instruments with strong focus of urban climate adaptation. The use of climatic information is unsystematic in urban planning sector.

2. What are the strengths and weaknesses of the legally binding instruments used?

√- Seoul metropolitan city government: The legal plan of framework act introduced a top-down approach to cope with Climate Change. Korea set up the National Government Adaptation Committee (NGAC) composed of the representatives of 13 ministries to implement the National Adaptation Strategy. Ministry of Environment (MOE) is in charge of the NGAC and also supporting local governments. The framework from top-down approach provided a ground for adaptation to local level government. However, the local level plans are not concretely set yet. National and local governments are looking at the big picture but have not got details for local actions. In addition, in recent days, the strong top-down

approach for climate adaptation has been often addressed as a problematic aspect of current policy making. Active community participation and involvement is required. Citizens and local community should be centered more on the entire process of policy and plan making.

⌂-Politician, member of Suwon city council: A climate adaptation strategy, policy and program must include other important assets or values. At present, 'emission trading'is only legally binding policy instrument and it only focuses on reducing the quantity of energy consumptions. If we stress too much only on this policy, other values such as public health is separated out as a focus, and not integrated into a more comprehensive adaptation capability.

❖-Suwon city government: There is a need for greater policy coherence across all sectors and levels of government. Most of local governments (city levels) in South Korea faces co-ordination challenges as a result of the involvement of different government ministries and agencies and the co-existence of separate plans for municipal economic development, spatial development, sectoral development and climate adaptation. A comprehensive, multi-sectoral national urban development plan could be pursued to generate more effective outcomes of climate response policy. Policy coherence at the urban/regional level could also be pursued by integrating climate adaptation and land use planning.

3. Are there certain chances / potentials missed when using the legally binding mentioned instruments(e.g. coupling with other instruments)?

√- Seoul metropolitan city government: As I have explained about the weakness of current policy systems, I think this question has been answered already.

4. Are there other policy instruments used to implement urban climate adaptation measures?
If yes, please explain how they work?

❖-Kiho Kim, the director of research institute for Climate Change Response: Seoul has started to identify the importance of building design to ensure accessibility of green public space for pedestrians, and laying out buildings of different height within a development so as to optimize availability of natural light across dwellings and reduce energy consumption.

◆-Landscape designers, office PARRKIM: I do not know well about existing policies or legal plans for climate adaptation measures. But, from my professional experience, I have thought of the new policy which puts architects and designers under an obligation on operating climate responsive ideas in their design. If this new policy suggests to cooperate amongst climate engineers, urban planners and urban/ landscape

designers, I guess it would help a lot to make a good system for creating public spaces respond to climate elements and aspects. The generation of new and innovative solutions would be also a benefit of that policy.

◈-Suwon city government: Similar to the emission trading, there are some more several instruments without legal force. Carbon-Point, Green Card, and Carbon Labeling System and Regulation on mileage and introduction of Bonus-Malus system in car pricing are the examples.

✱- Haedong Kim, Climate expert, professor of Keimyung University: I would give same answers for this questions. There is a policy gap in Daegu in regards to urban climate adaptation and implementing measures.

5. What are the strengths and weaknesses of the other policy instruments used?

◈-Suwon city government: The measures that I have mentioned are the way to limit the quantity of energy consumption. This has caused many conflicts already. For example, many factories suffer with doing their productions with less use of energy. The expansion of new and renewable e nergy production would be as a stronger measure to overcome this point.

Implementation

1. Which concrete urban climate adaptation measures/ interventions are currently implemented or have been implemented in your city?

√-Seoul metropolitan city government: Adaptation measures vary depending on many factors. For example, they can be classified based on the timing, goal or the sectors considered. We aim to prepare for the wide variety of adaptation measures. It is crucial to know which measure to use in which situation. Thinking of example adaptation measures with the classification based on the timing, there are two types, one is for long-term and the other is for short-term. We have focused more on using short term measures for adaptation rather than long term using measures. Short term temporary measures are for managing emergent moments. This includes alert system, temporary shelters for extreme heat wave, fog and misting systems for rapid outdoor cooling. Emergency medical care in the event of climate disaster is also one of temporary adaptation measures for climate vulnerable class.

✣-Kiho Kim, the director of research institute for Climate Change Response: I would say that urban vegetation is the most concrete and common measure in use. Perhaps they are not yet implemented 'concretely' as the measures for cooling down temperature of Seoul. But somehow there is a great interest in offering more urban green spaces and vegetation in Seoul which is very effective both for mitigation and adaptation. Basically increasing the numbers of urban vegetation has gotten attention for long times to make a green city. Planners and urban landscape designers just used to work with and for them without being aware of its cooling effect.

❖-Suwon city government: In Suwon, the most concretely implemented measures are policy and regulatory measures. As I explained earlier, the planning factors of low carbon green city are related to the green city planning which is undertaken by Suwon municipality. This has driven regulations such as financial and tax supporting policies for promoting reduction of greenhouse gas, quantity management plans related to regional emission approval. We have considered providing various types of technical measures too in the city, but the concrete implementation has not been conducted. Perhaps urban greenery is the most common technical measure in use at present.

✖-Daegu city government, planning department: In Daegu, the importance of urban vegetation and the shadow that they create has often been stressed to cool down the city temperature. In particular, special emphasis has been attached to implementing green roofs on existing buildings. (And there is a growing interest in use of materials and creating wind corridor for air ventilations but these have not been concretely implemented in practices.)

2. What are the strengths and weaknesses of these mentioned urban climate measures/ interventions?

√-Seoul metropolitan city government: I think we have made a good start to consider and prepare for both mitigation and adaptation measures in our planning. However more focuses and attentions are required for further steps of the actual implication. In terms of the long term measures, local and district level information and knowledge are required for supporting each locals and districts to get the relevant adaptation

options. In Seoul, provisions of district scale application guidelines and tools for climate change adaptation is weak.

◈-Suwon city government: Those regulatory measures that we have are the way to limit the quantity of energy consumption. To limit has limitations and occurs various conflicts. Other effective response measures also should be implement to overcome this limitations.

✖- Daegu city government, planning department: Urban greenery and vegetation have a wide range of beneficial effects on the environment and on people's health. However, there are also problems difficulties relating to the use of urban vegetation. For example, green roofs or walls can increase the risk of fire hazards, and they can contribute to increased levels of pollen, leaves and dirt on mechanical units.
Moreover, it can also be quite expensive in terms of money and labor to maintain urban vegetation such as rooftop garden and wall.

✱- Haedong Kim, Climate expert, professor of Keimyung University: Offering scientific knowledge and evidence-based adaptation measures requires to match between the types of climate information and data availability, and meet the policy makers' needs. In Daegu, climate information and data availability is strong but the interest of policy maker is weak.

3. Are there conflicts between aesthetics and these mentioned urban climate adaptation measures?

v-Seoul metropolitan city government: Perhaps aesthetical conflicts can exist with the measures that I mentioned. But I don't have strong certain experience for that. I suppose other types of conflicts more strong and significant to implement adaptation measures.

◈-Suwon city government: The regulatory measures are mainly about controlling behaviors, therefore they do not conflict with aesthetical values.

✖- Daegu city government, planning department: I do not see strong conflicts between urban vegetation and aesthetics. In general, urban vegetation enhance aesthetical values.

✱- Haedong Kim, Climate expert, professor of Keimyung University: For the building materials measures, perhaps some aesthetical conflicts can be emerged between measures and architects or designers. For example, pursuing the use of light-color materials can conflict with original design intentions.

4.Are there conflicts between urban functions and these mentioned urban climate adaptation measures?

◆-Landscape designers, office PARKKIM: People from the different backgrounds always have different interests, this is the biggest barrier for implementing climate adaptation measures.

❖-Suwon city government: The regulatory measures and policies mostly conflict with business opportunities, economic and industrial development interests.

✖- Daegu city government, planning department: Conflicts between different property owners can be caused by constructing and planting urban vegetation on the existing buildings. Relationship to other structures and buildings in terms of wind and shading must be considered.
There are also cost-based conflicts associated with the construction and maintenance of urban vegetation.

✱- Haedong Kim, Climate expert, professor of Keimyung University: Financing problem is the barrier to implementation. But this has been improved by governments support. For example, Daegu city government has a plan for supporting financial funds to build green roofs on the commercial buildings. The maximum percentage for support is 50~80% of building cost for green roofs until 2018.

5. Are there certain chances/ potentials (e.g. coupling with other interventions / 'no regret' measures) missed when implementing these mentioned urban climate adaptation measures?

✱- Haedong Kim, Climate expert, professor of Keimyung University: In Daegu, the case of an integration between other types of measure is very rare. To generate multifunctional benefits of adaptation measures, integrations among different measures is required. For example, establishing a safety infrastructure to prevent from climate induced disasters, and implementing various types of measure in this infrastructure.

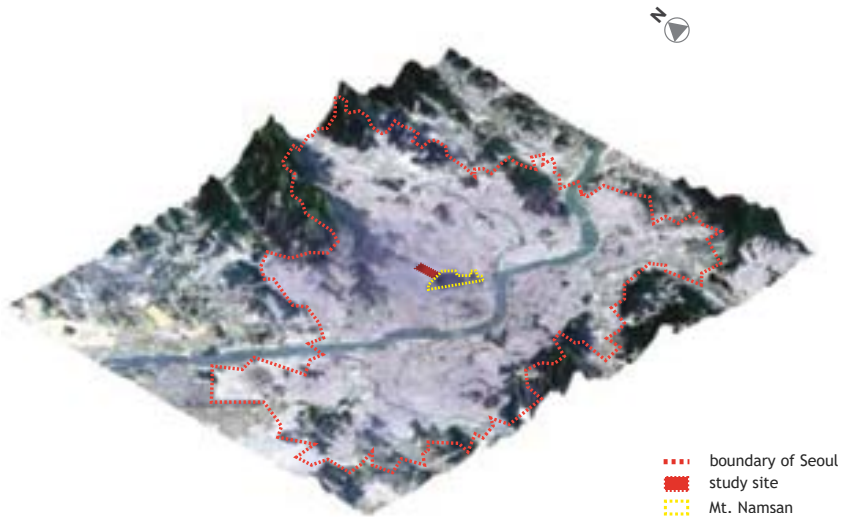


Fig.X.1 Topography of Seoul

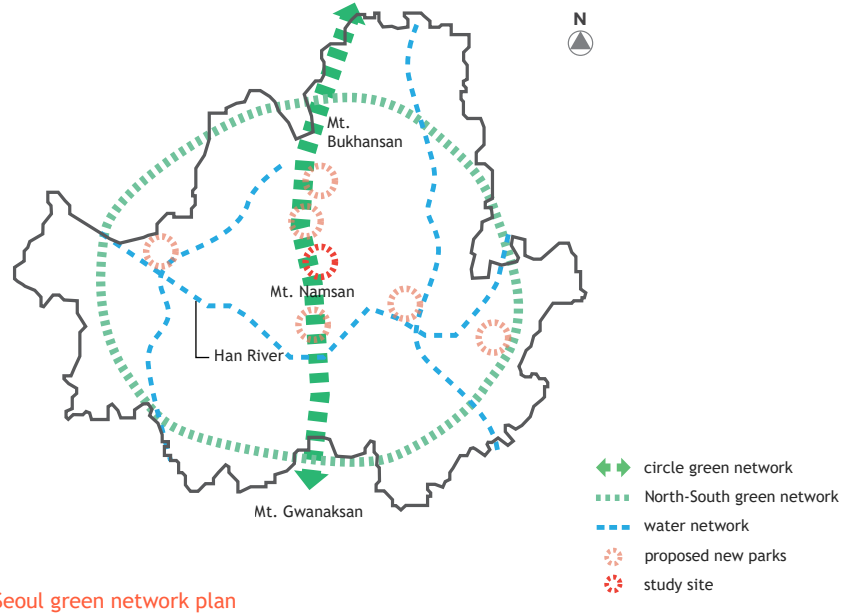


Fig.X.2 Seoul green network plan

Topography

- Topography of Seoul and location of the site

Seoul has the mountainous topography. The city is surrounded by mountains about 700-800 meters high. Neighbouring mountain of the study area is Namsan Mountain with the height of 256m above the sea level. Namsan Mountain is considered as the important symbol of Seoul, because it is located in the centre of Seoul and it was located across from the palace (Fig.X.1).

The Han River, a major river in South Korea, flows from the East to the West between the mountains. There are also tributary streams of the Han River. As one of this tributary streams, Cheonggyechon which runs through the study area has been recently restored and has become a significant public resting area in Seoul.

In addition, the study area is located on the part of the green network of Seoul (Seoul Metropolitan Government 2006B). Beside the Circle Network surrounding the Seoul area, the North-South network is running from Mt. Bukhansan (North) over Mt. Namsan to Mt. Gwanaksan (South). The selected site is located on this N-S green network (Fig.X.2).

- Beneficial effects from surrounding topography
Although, the site area is located in urban core zone of Seoul, there are also neighbouring natural and open areas like Namsan Mountain, Jongmyo Shrine, and Cheonggye Stream.

The neighbouring natural areas can contribute to beneficial effects on the air temperature conditions of the site.

As it has been addressed in the ‘site selection’ part, Namsan Mountain, located just South of the site area at higher altitudes, can play an important role for the neighbouring areas with its high cold air productivity.

Open natural spaces like Jongmyo Shrine and Cheonggye Stream in the North part of the site area, also possess potentials for cooling effects.

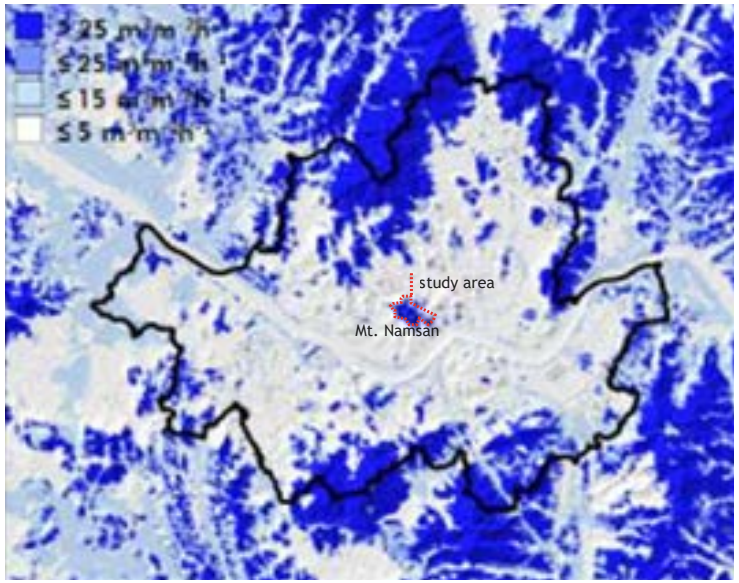


Fig.X.3 Site location in the boundary of Seoul and topographic benefit on cold air productivity

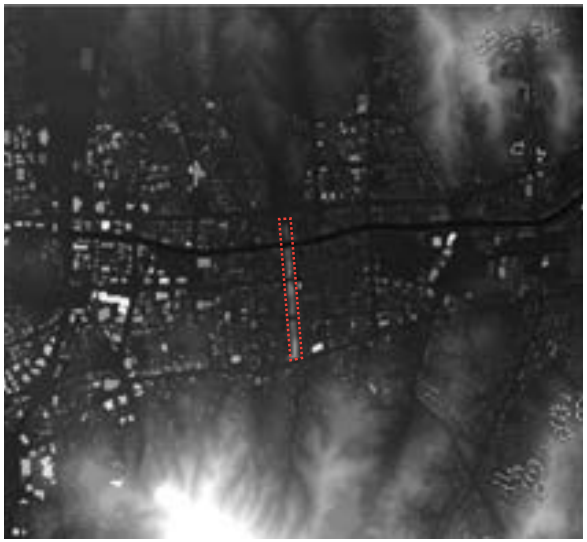


Fig.X.4 Digital elevation model

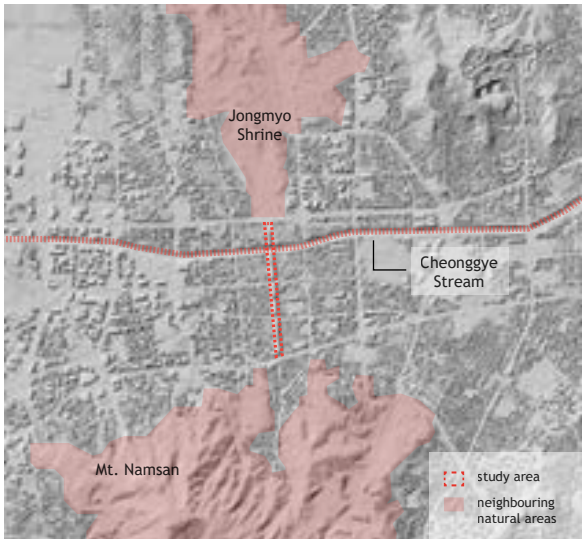


Fig.X.5 Topography and altitude of study site

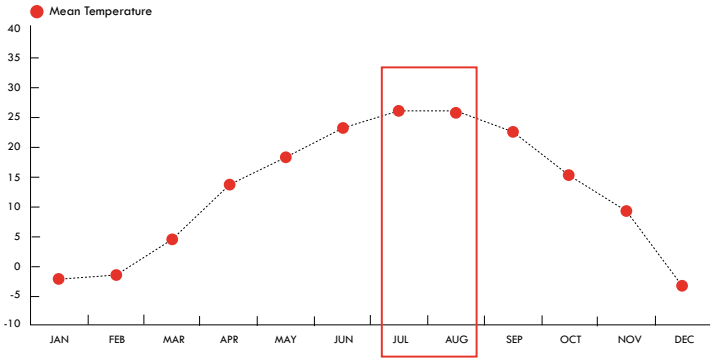


Fig.X.6 Monthly mean temperature and precipitation, 2005

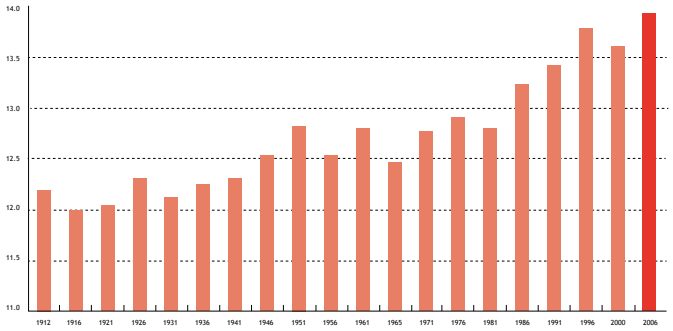


Fig.X.7 Changes in mean air temperature of Korean Peninsula

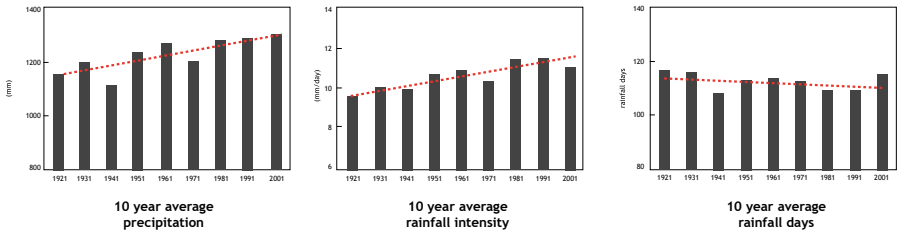


Fig.X.8 Variations in rainfall patterns of Korean Peninsula

Climate

Being the Northeast of the Asian continent, Seoul's climate lies between subtropical climate of the Southern region and sub-solar climate of the Northern region. It has four distinct seasons, and wide annual range of temperature. Winter is bitterly cold and dry, due to the high atmospheric pressure developed over the continental landmass. In summer, air masses moving in from the Pacific Ocean cause hot and humid weather. Spring and fall, the transitional seasons, are characterized by mostly clear and dry days.

- Temperature

The hottest month is August, with average temperatures from about 24 to 29°C. In January, the coldest month, average temperatures range from -6 to 7°C. During May and October, the core months of the spring and fall seasons, the temperatures range between 16 to 19°C and 11 to 19°C respectively.

- Precipitation

Being the centre of the Korean Peninsula, annual precipitation in the Seoul Metropolitan region ranges between 1100 and 1400mm. About 50 to 60 percent of the annual rainfall occurs during the summer months, nearly half of it during the monsoon (heavy rain) season, which usually continues for a month from late June until late July. Humidity remains high throughout July and August, reaching about 80 percent.

As it is shown in the statistics data from Korean Meteorological Administration (Fig.X.7 and Fig.X.8), South Korea is experiencing an obvious and rapid temperature and precipitation increase.
The annual mean temperature shows an upward trend at a rate of 0.52 °C per decade in the past four to five decades.
The amount of rainfall in the last 10 years has also increased because of the number of heavy rain and torrential rain events having increased in frequency.

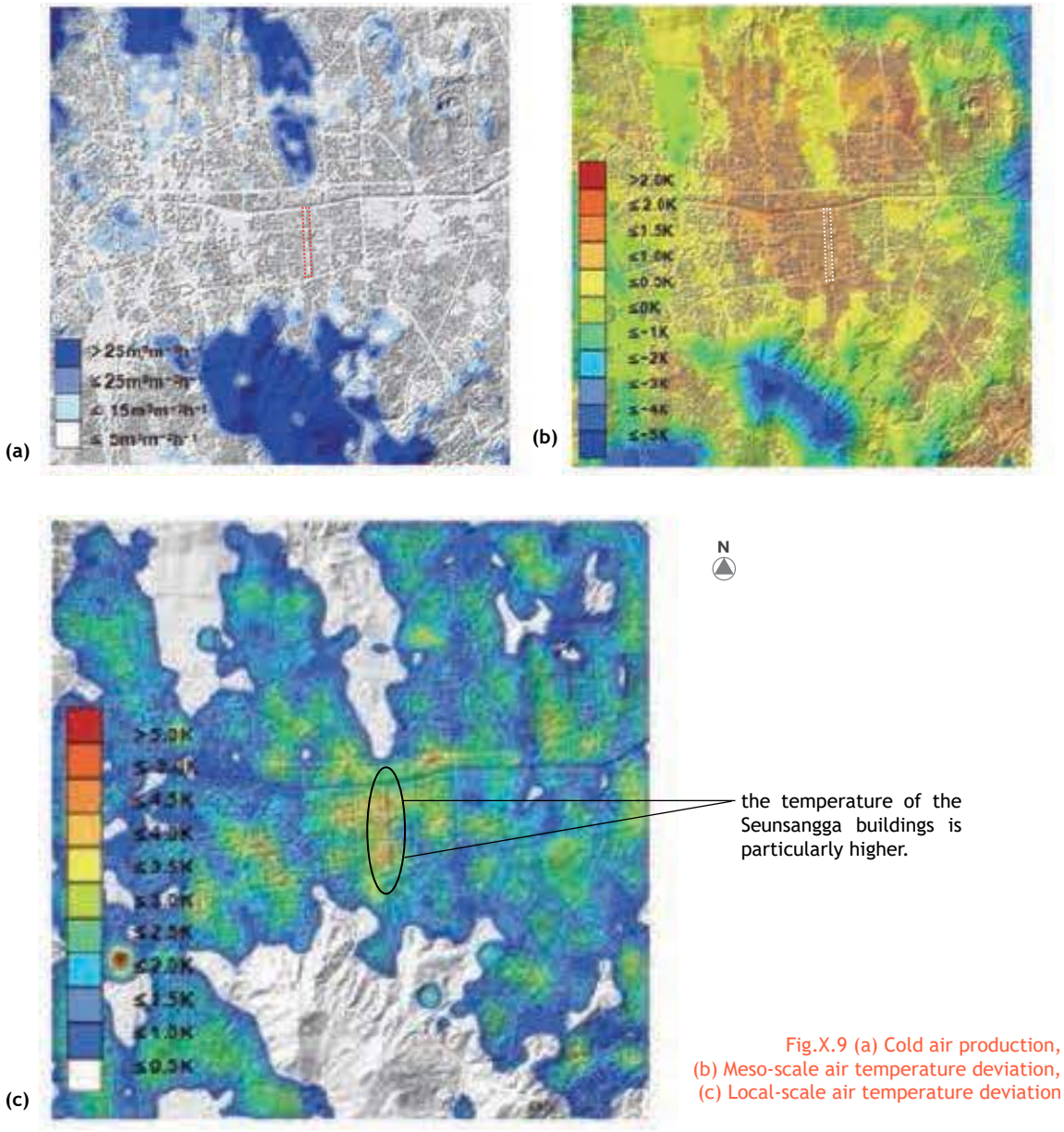


Fig.X.9 (a) Cold air production,
(b) Meso-scale air temperature deviation,
(c) Local-scale air temperature deviation

Local urban climate analysis

Information for local urban climate conditions of the study area is able to get from 'CAS (Climate Analysis Seoul)'. Quantitative analyses conducted by CAS for the production, transportation, and stagnation of cold air, wind flow and thermal conditions by incorporating GIS analysis on land cover and elevation (Kwon et al. 2015).

In this section, I indicate significant climatic facts occurred in the study area that are resulted from analysing data of CAS.

- Air temperature of the study area

Data in Fig.X.9 address the condition of air temperature in the study area. Compared to the neighbouring natural areas that can produce cold air, the study area has obviously higher temperature. As it is clearly shown in Local-scale air temperature deviation (Fig.X.9 (c)), the temperature of the area that Seunsangga buildings exits is particularly higher than the other surrounding areas. Therefore, it is urgent to implement heat adaptation measure on the site.

Fig.X.10 Used materials in study area

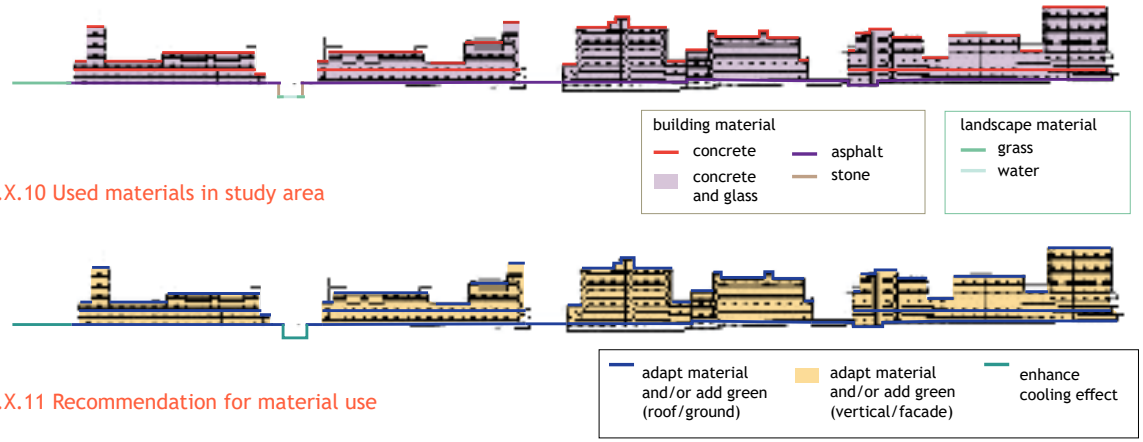


Fig.X.11 Recommendation for material use

Material use

In terms of material use in the site area, building materials are much dominant than the natural landscape materials. In the buildings, grey or white concrete is used as the major exterior material, and all of the traffic roads and narrow alleyways between buildings are covered by asphalt. All these used building materials possess high emissivity and thermal conductivity which have a negative influence on increasing heat risks in the site. With its grand scale, Seun sangga buildings has a much larger surface than other objects at the site, and it receives and emits more radiation.

In addition, the materials in the site also have influences on psychological factors of the spatial and thermal experience. Due to the deterioration of buildings, concretes of the exterior surface and metals in the inside structures are kept in very bad conditions. It becomes the major factor that make the site unpleasure place to visit with desolate atmosphere.

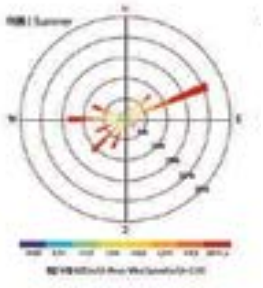
The factors albedo, emissivity and thermal conductivity have a great influence on thermoregulation in cities (Lenzholzer, 2015). Therefore, the choices of suitable materials should be carefully considered combining with the purpose of the space and thermal effects. Adding natural materials in landscape design will be the great solution to the site. For example, green roofs and green facades for building surfaces and planting roadside trees and gravel paving for roads and alleyways. Once the surface material is changed for better thermal conditions, the vertical surface of Seun sangga buildings can possess much greater benefits than any other objects in the site because of its mega scale.

- Wind

According to the data of Automatic Weather Stations (AWS) in 2005, an annual wind of 1.9m/s, and the wind speed is the highest in March and April, and the lowest in October.

During the summer, south-south-west wind is a prevailing wind, and north-westerly wind is the common type of wind in winter.

Average wind speeds in Seoul have tended to decrease since the 1970s (FIg.X.14). Changes in wind patterns are presumably associated with rapid urban development of large-scale apartment complexes and high-rise office buildings. (Oh et al., 2010)



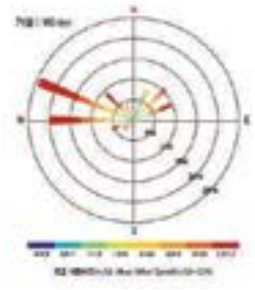


Fig.X.13 Seasonal wind rose
Summer (left) and winter(right)

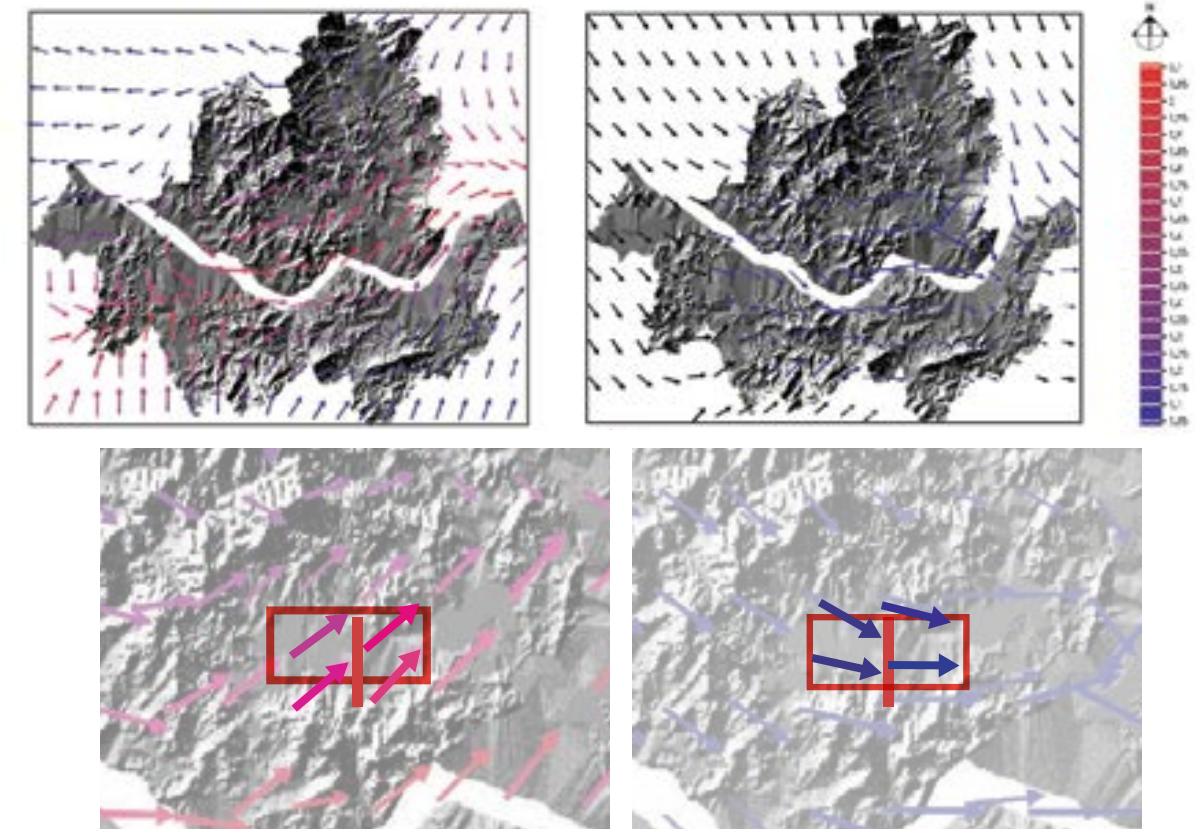


Fig.X.12 Summer (left) and winter(right) wind direction and speed
Source: Seoul Metropolitan Government, The map of meteorology in Seoul (the 1st year) 2013

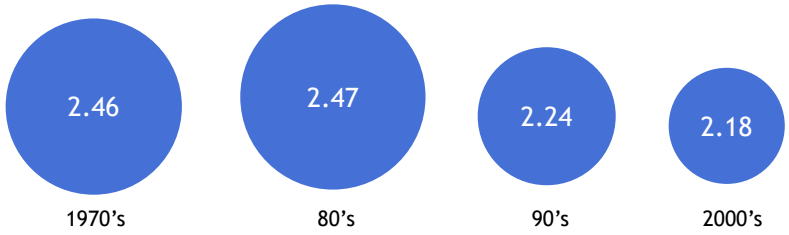


Fig.X.14 Reduced wind speed

- Wind in the study area

As it is indicated in Fig.X.15, complex flow of wind around Seunsangga commercial buildings and surrounding buildings showed. Wind speeds around buildings and stores largely tend to decline compared to the influx from out of the study area due to masking effects of the buildings. Very few void spaces exit in the site area and they are hardly ventilated with wind.

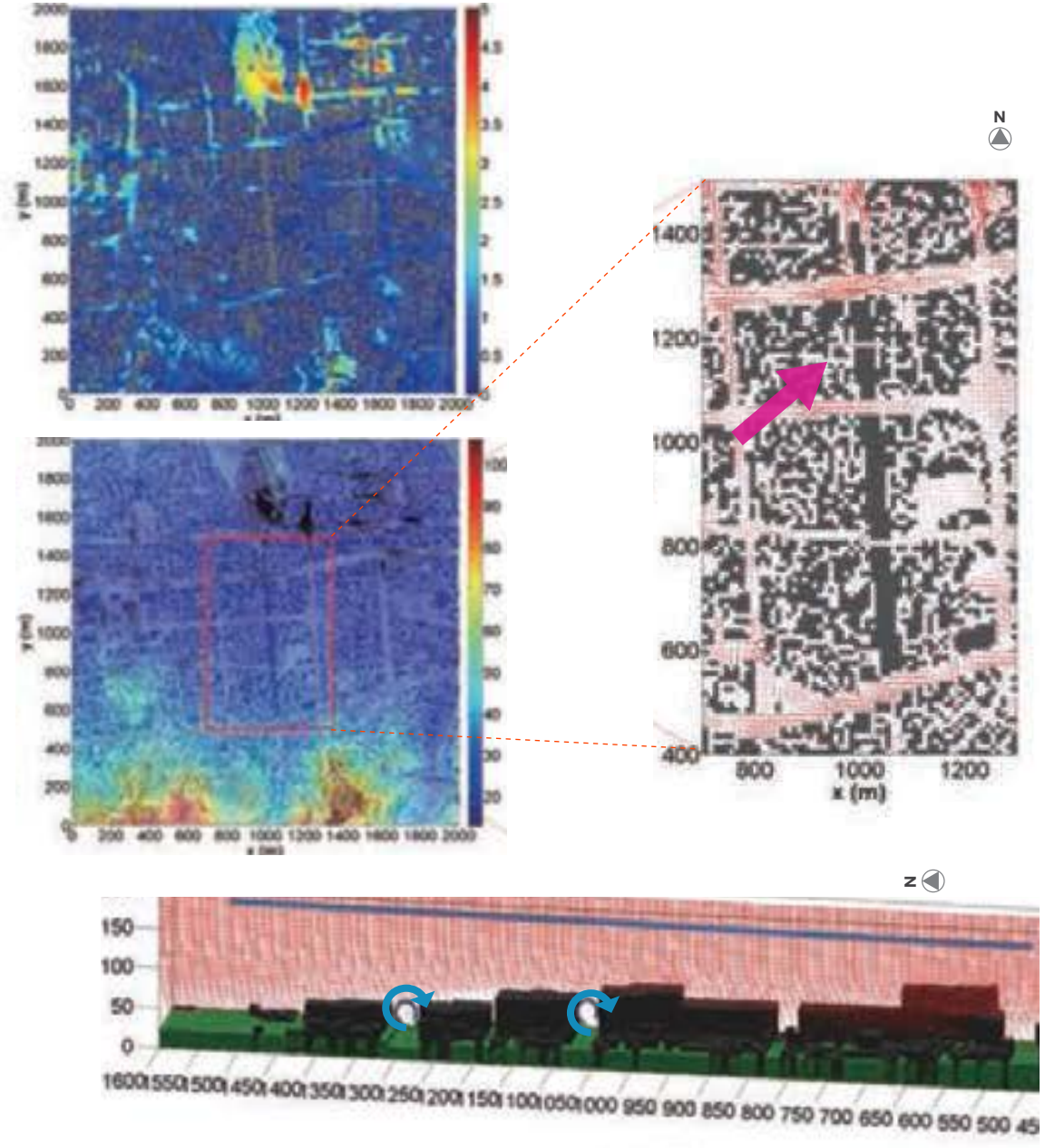


Fig.X.15 Wind environment(wind speed, vector field) around Seun commercial street

Rainwater drainage and flood occurrence

Based on the topographic conditions, Han River and its tributary streams play an important role for discharging rainwater as the major drainage basins located at the lowlands of Seoul.

Throughout the city, the current urban water system mostly relies on the pipe based collection and drainage system to transport rain water to the neighbouring tributary streams which then discharge water to the Han River.

After urbanization occurred in Seoul, there is an rapid increase of impervious surfaces in the city due to urban development. This has become one of the main causes of significant flood problem in Seoul during the heavy rain brought by monsoon in summer period. As it is indicated in Fig.X.18, the study area is also exposed to the risks of flooding. In the study area, the terrain height decreases both from the North to the South and from the South to the North (Fig.X.19). With this topographic condition, the general rainfall direction flows toward to Cheonggye stream basin which flows through the North part of the site, therefore the area near the stream, are particularly venerable to floods. Moreover, impervious surfaces may also aggravate the infiltration of the site area. Recently some detention ponds are constructed near Namsan Mountain, but proposing more creative storm water management strategies would be beneficial to the site area.

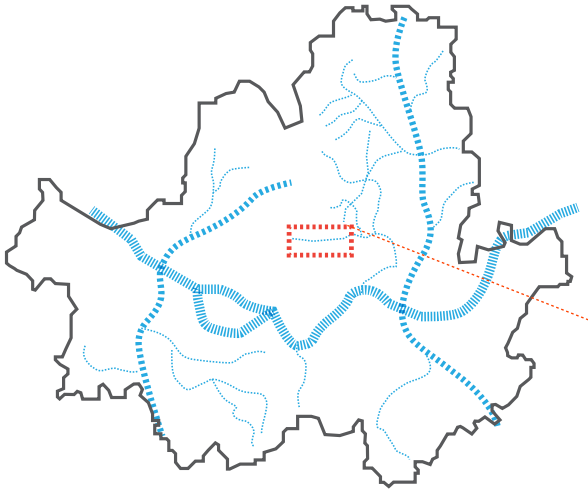


Fig.X.16 Seoul's major river and tributary streams that play an important role for discharging rainwater

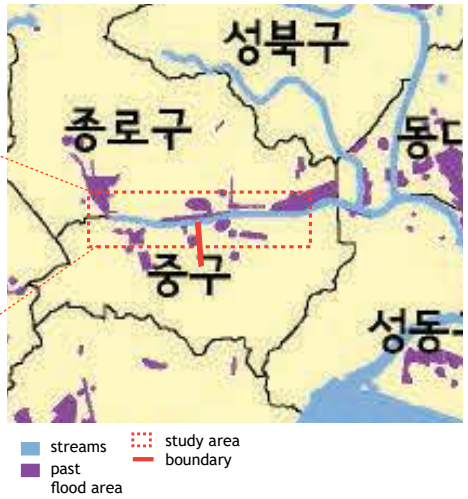


Fig.X.17 Study boundary and past flood area

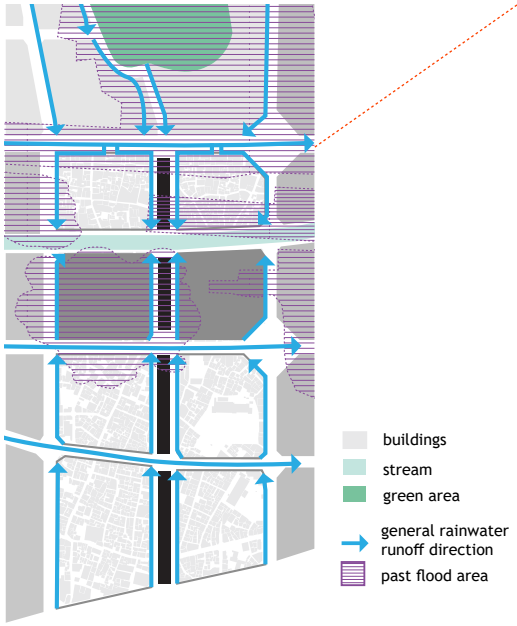


Fig.X.18 Past flood area near the site boundary

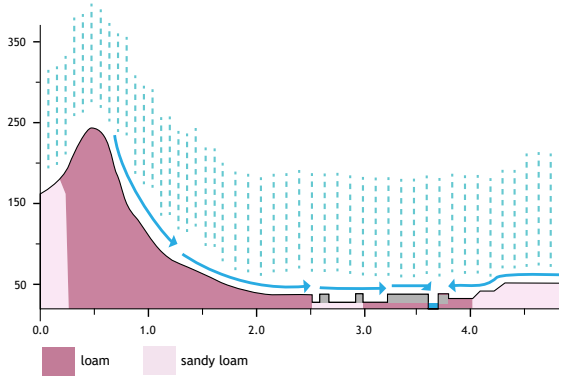


Fig.X.19 Landscape profile of the site with topographic conditions and rainwater drainage direction

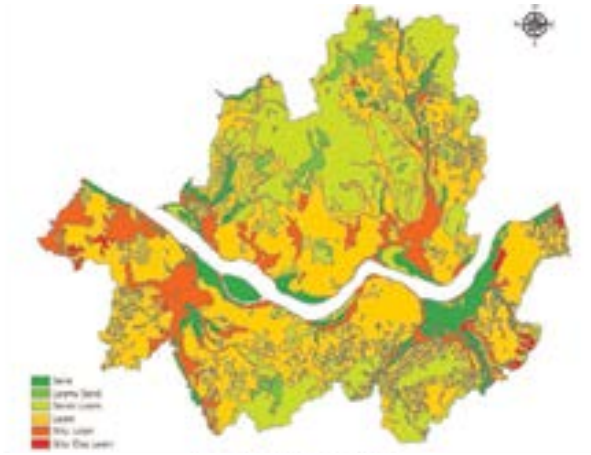


Fig.X.20 Soil types in Seoul

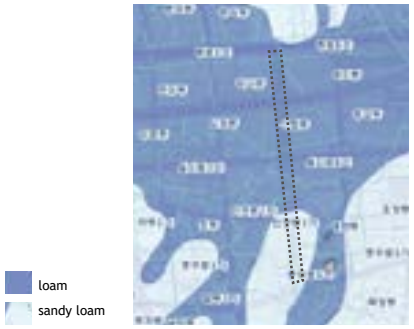


Fig.X.21 Soil types in study area

Fig.X.22 Soil colours, loam (above), sandy loam (below)

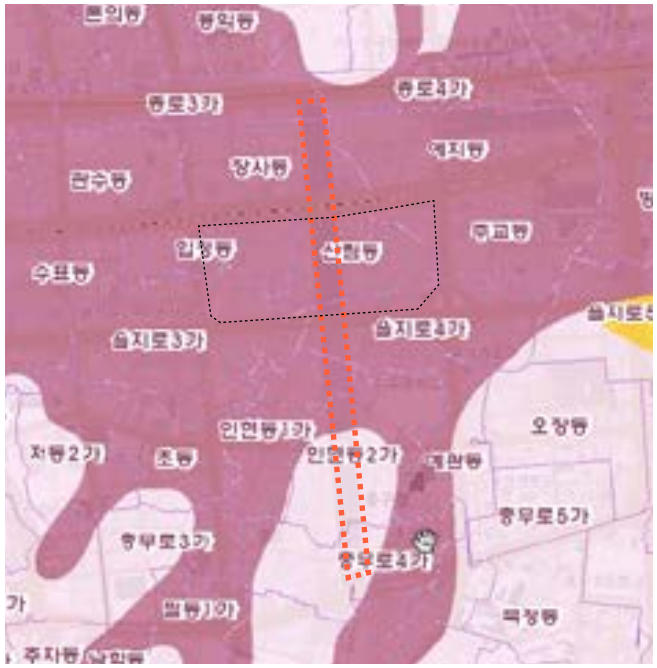


Fig.X.23 Infiltration rates for soil types

Soil

Soil types in the study area are loam and sandy loam. They are composed mostly of sand and silt, and a smaller amount of clay (about 40%-40%-20% concentration, respectively).

Loam and sandy loams generally contain more nutrients, moisture, and humus than other types of sandy soils. Loam soil feels soft and crumbly and is easy to work over a wide range of moisture conditions. Loam soils are found in a majority of successful farms because they are ideal for gardening and agricultural uses because it retains nutrients well and retains water while still allowing excess water to drain away. Therefore, urban agriculture will also be a great potential for the new and productive function on this area.

Loam soil is the mixture of sand, silt and clay, which makes it a moderate soil type for infiltration.
sandy loam (20 - 30)
loam(10 - 20)

(Source: adapted from http://www.fao.org/docrep/s8684e/s8684e0a.htm)

Flora

Native plants in the site area are used to the local climate and easily grow up in this region. Therefore, it is important to explore what kind of plant growing in the site area.

In terms of designing thermal comfort place, plants can be the effective solution to create shading and reduce solar radiation on buildings and spaces. The extent of shading effect can differ depending on the size of plants and density of their foliage (Lenzholzer, 2015, p.130). Therefore, studying on the types and characteristics of the plants will be very helpful for selecting plants in later design part.

In this section, first, I classified the native plants into tree, shrub and grass, then each plants are studied concerning their size, characteristics of foliage. The effect of shading and evaporation are also examined depending on the plant types.

Needle leaf trees such as pine trees will have a much greater evaporation effect than a deciduous tree such as an oak tree. Even though the pine needle can be very small, the needles have much more surface area than deciduous leaves allowing for more transpiration. (information adapted from: http://www.stevenswater.com/articles/etbasics.aspx)

Example

Betula nigra

-height: 25-30m

small | medium | large ← This indicates that the plant size is large

-foliage: ovate, large, deciduous ← This section explains the characteristics of foliage such as shape, size, density and classification etc.

-shading effect:

very weak | weak | mid | strong | very strong ← This indicates that shading effect is strong

-evaporation effect:

very weak | weak | mid | strong | very strong ← This indicates that evaporation effect is strong

Tree

Pinus Densiflora
20-35m
foliage: needle, 12cm long, evergreen

Pinus Rigida
30m
foliage: needle, fascicle, 13cm long, evergreen

Quercus Mongolica
30m
foliage: obovate, narrow, 23cm long, deciduous

Quercus Serrata
25m
foliage: elliptical, dense, 17cm long, deciduous

Robinia Pseudoacacia
12-30m
foliage: pinnate, 25cm long, deciduous

Wisteria Floribunda
9m
foliage: pinnate, 30cm long, deciduous

1.5.2. Shrub

Berberis Koreana

1.5m

foliage: elliptical, dense, 10cm long, deciduous

Hydrangea Serrata

1.2m

foliage: obovate, 15cm long, deciduous

Forsythia

1-3m

foliage: oval, small leaflets, 10cm long, deciduous

Rhododendron schlippenbachii

1-2m

foliage: obovate, 7.5cm long, deciduous

Smaller plants have lower evapotranspiration than large plants, since they have less foliage. However, these plants can add the evaporation from the soil since they usually grow in the earth. In addition, low vegetation is also important for the biodiversity in the city and has strong aesthetic effect too (Lenzholzer, 2015., p.165).

1.5.3. Grass

Bambusa Vulgaris

20m

foliage: long papery leaves, perennial evergreen

Polystichum Munitum

50-180cm

foliage: lush evergreen ground cover

Jeffersonia Dubia

30cm

foliage: narrow lanceolate, evergreen

Iris Koreana

20-35cm

foliage: deciduous

Sesleria autumnalis

30cm

foliage: narrow light leaf, evergreen

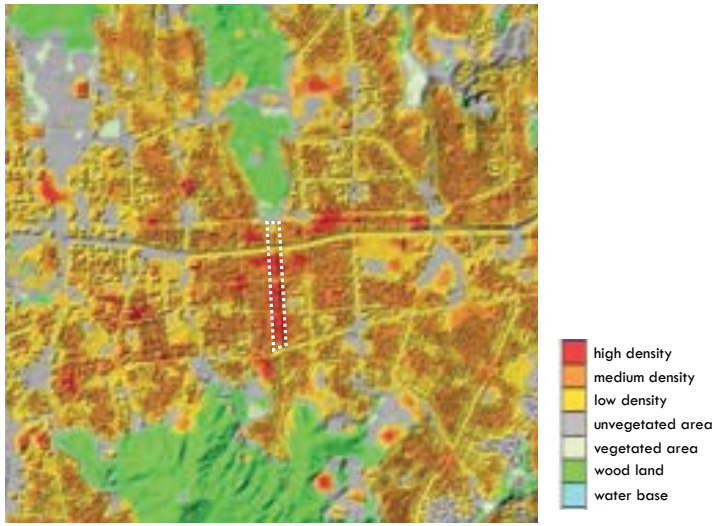


Fig.X.24 Land use of study area

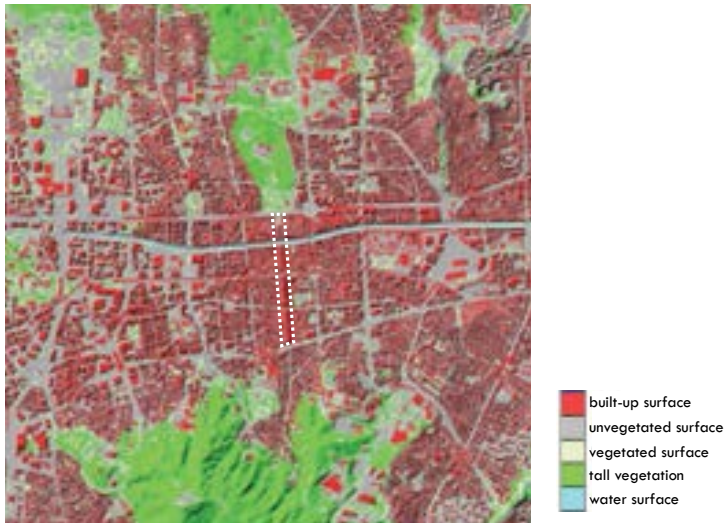


Fig.X.25 Land surface of study area

Land use and surface cover

As it is shown in Fig.X.24 and Fig.X.25, the area in the study site boundary is dominated by densely built-up land use surface with very closely attached buildings and few green spaces, A high local surface influence, which appeared in most parts of the study area, contribute to a strong heat island effect with low humidity.

Ventilation cannot flow through the attached building structures, indicating high surface roughness. Therefore it can be estimated that high levels of air pollution and thermal emission can be present on the study area.

Since Seoul city government has great interest in new development for revitalizing this site, the Seun sangga building and surrounding districts are available for changing its land use or type of industry. Land use change planning measures should be considered to avoid or reduce thermal stress risks in this area.

Building size and scale comparison

Seunsangga Complex consists of seven buildings. The 50 meters wide and 1.2 Km long mega-structure is often called as monster in the heart of Seoul.

A mega-structure is a very large man-made object, though the limits of precisely how large this is vary considerably. Some apply the term to any especially large or tall building. The creation of the mega structures were bold attempts in a structural point of view in the 1960s, when urbanization processed rapidly. Seunsangga in Seoul covers the longest standing area compared with other mega structures that was built in 1960s in other countries such as Berlin, London, Cumbernauld, France, Montreal, and Tokyo. (Kang, 2011)

Fig.X.26 composition of seven buildings in Seunsangga Complex

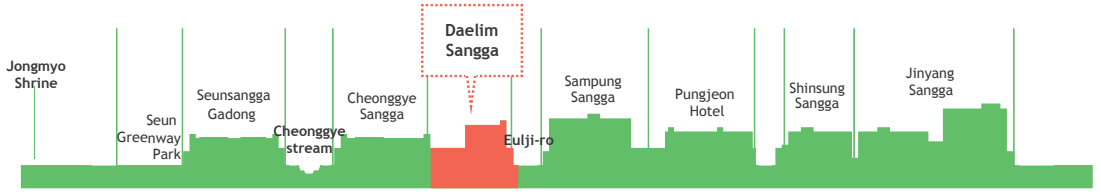
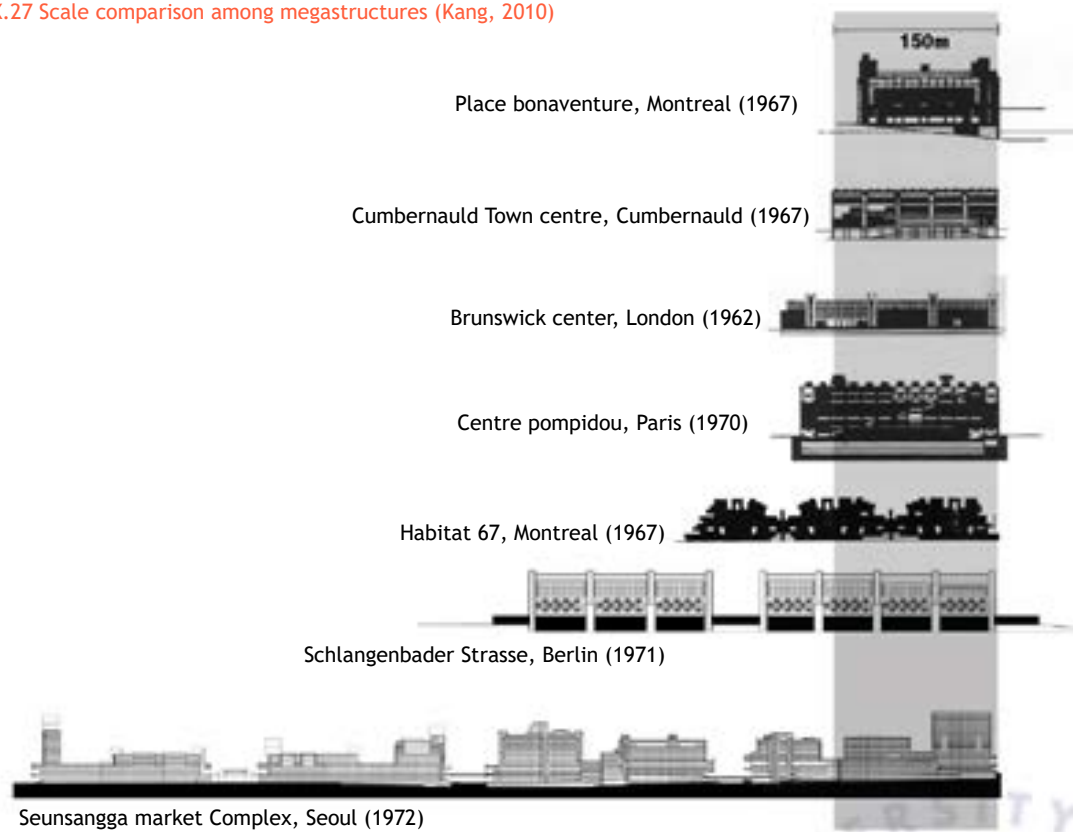


Fig.X.27 Scale comparison among megastructures (Kang, 2010)



Building structure study

Understanding structure and scale of the buildings and spaces between them are very important for designing details and implementing urban climate adaptation measures in the design phase later on. Therefore, sections and axonometric drawings of buildings are drawn in this part in order to understand spatial reality of the design area.

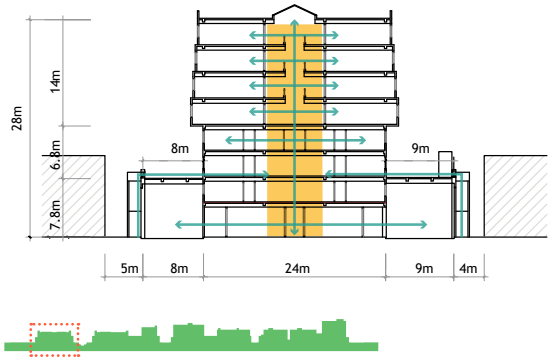


Fig.X.28 Cheonggye-Sangga section drawing

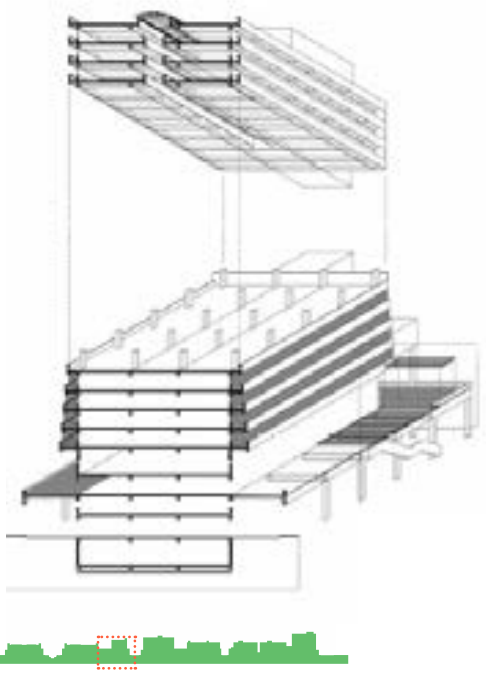


Fig.X.29 Daelim Sangga axonometric drawing

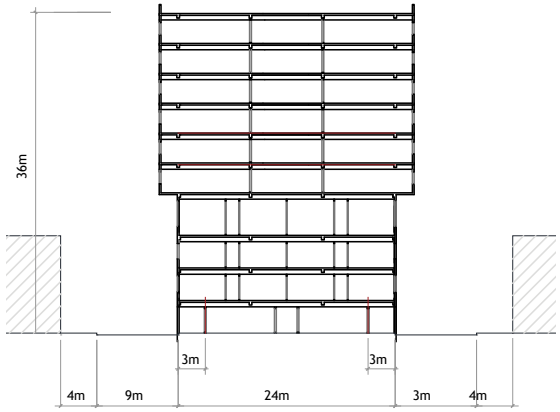


Fig.X.30 Pungjeon Hotel - section drawing

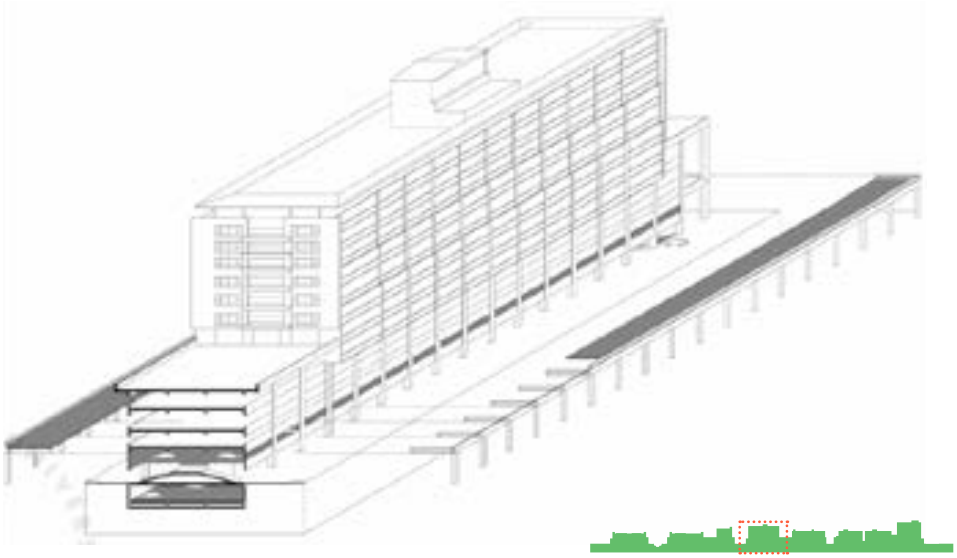


Fig.X.31 Sampung Sangga axonometric drawing

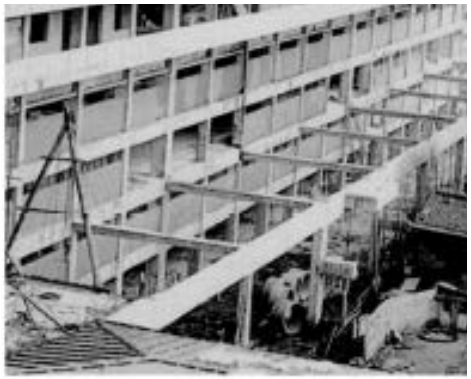


Fig.X.32 Base structure of Seunsangga complex buildings

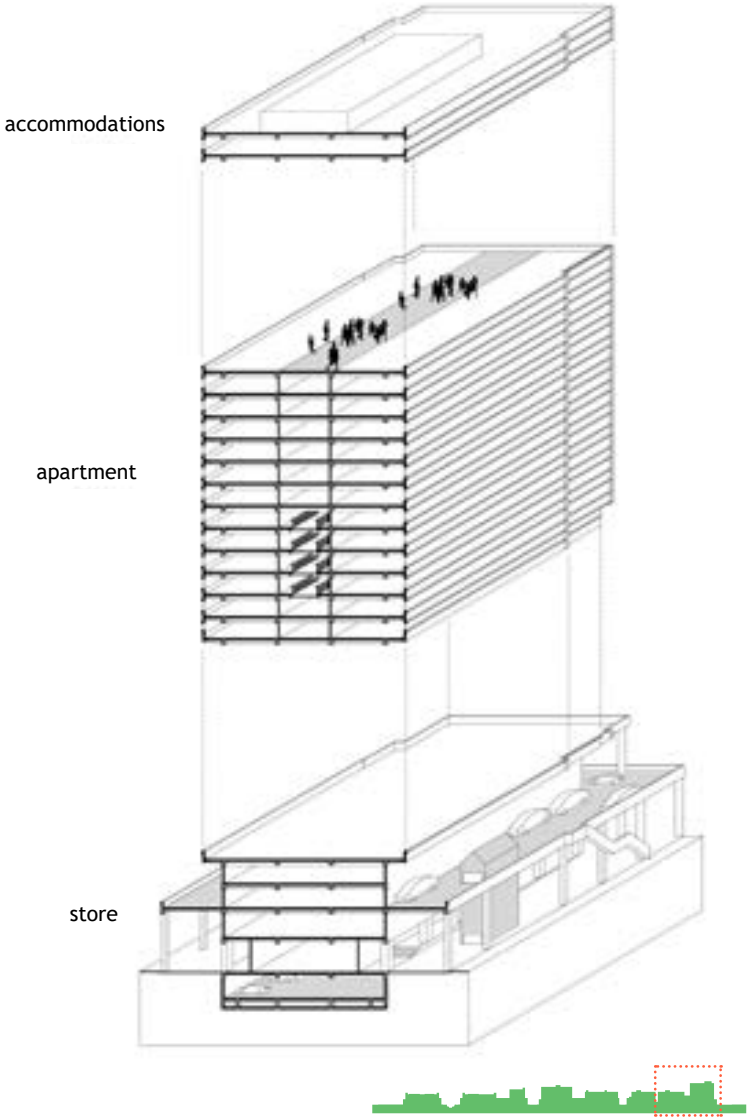


Fig.X.33 Jinyang Sangga axonometric drawing

Fig.X.34 Seun district Industry map

Fig.X.35 Building use change of Huyndai, Seunsangga Gadong, Cheonggye, Daelim-Sangga

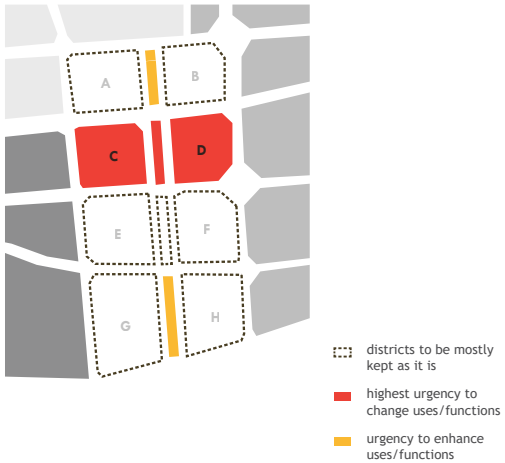


Fig.X.36 Conclusion map on uses and activities in buildings and surrounding districts

Use of buildings and surrounding areas

Seun Sangga buildings and surrounding districts are old electronics market and shopping area. Business in this market area declined since internet market has been actively developed.

Most of shops and buildings have bad conditions. In particular, District C and D almost went to ruin. Redevelopment and revitalization can be considered through changing use or structure of the buildings and surrounding districts.

Space types and activities

The outdoor activities are influenced by a number of conditions. Physical environment and its conditions are the major factors. In Fig.X.37, the spatial types in the study area are classified with 5 categories and current human activities are defined depending on the classified categories.

Human activities also take place in different time patterns associating with the types and the uses of space. Different time patterns are also related to the change of urban climate, therefore these facts have to be considered for implementing appropriate climate adaptation measures. In Fig.X.38, it has been identified that the areas with different activity types by time patterns.

Fig.X.37 Spatial types and current activities

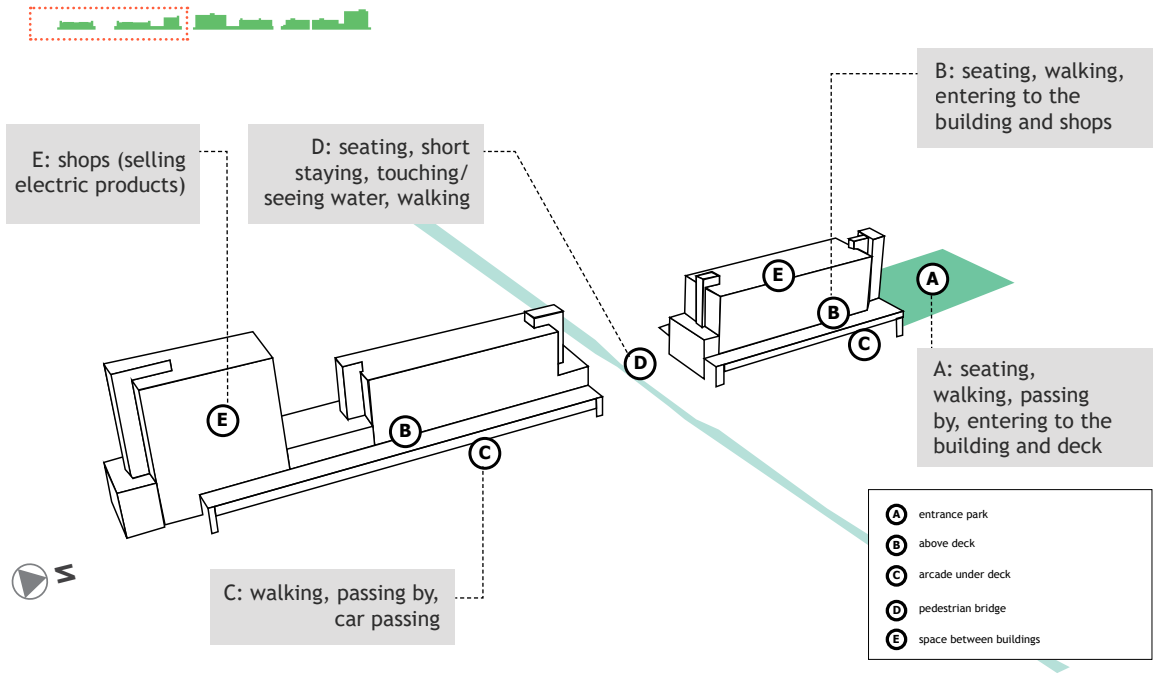


Fig.X.38 Activities with different time patterns and area uses

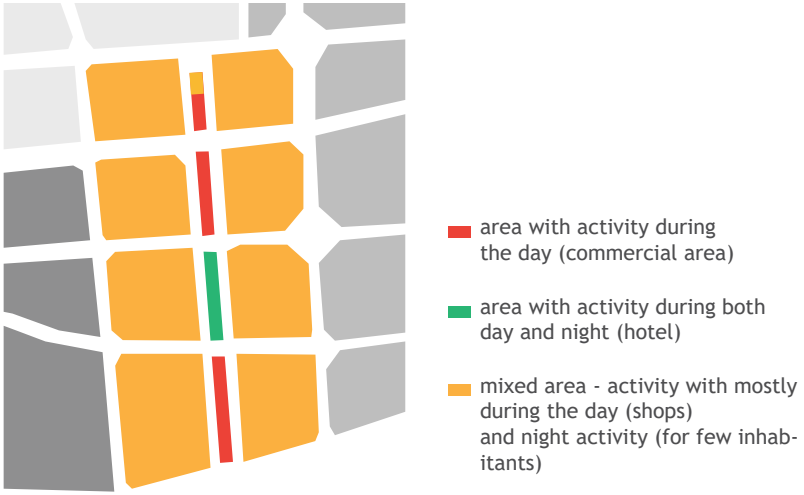


Fig.X.39 Green space in the site

Jongmyo shrine

Seun greenway park

Chyeongyechoen river park

Sports field in the school

Green space

The Seun sangga building has lack of green and tree planting. However, some major green space exist in the surrounding area. In map Fig,X.39, 4 existing green/open spaces are described with photos. Areas that are proposed to be new green open spaces are also marked in this map. Good connection would be required among these new and existing green spaces.

Public space between buildings

The Seunsangga building is a private facility. Between the buildings, however, there are public and semi-public space exist which people can share with (Fig.X.40). For example, decks, and spaces in the roof top offer people some shared space. In the following sections, the shared public spaces between the buildings will be described with detail information.

- Deck of Seunsangga Complex

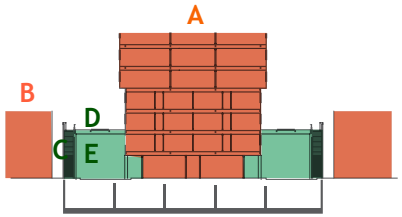
Deck size details:
Width 8.5~9m
Length Approx. 860m

Seunsangga Complex's deck is a public facility created on an urban planning road located on the 3rd floor of the east and west wings. Part of the deck are occupied by stores and parking lots. The area below the deck are roads and parking lots.

Recent safety examination revealed the deck (Seunsangga Gadong did not carry out safely examination) has a grade D rating which requires structural reinforcing.

Fig.X.40 Space types between the buildings

N-S section of the building



W-E section of the building and deck

photo analysis - space between the building and deck

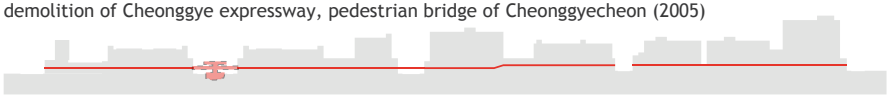
A interior view of Seunsangga B shops

C stairway to deck D above deck

completion of Seunsangga complex, pedestrian bridge over Mareunnae-gil was not constructed (1972)

completion of Cheonggye expressway (1971)

demolition of Cheonggye expressway, pedestrian bridge of Cheonggyecheon (2005)



demolition of Sampung-Sangga and Pungjeon Hotel's deck (2006)

demolition of Hyndai-Sangga (2008)

present (2015)

pedestrian bridge and Cheonggyecheon-ro (1968)

- Pedestrian Bridge of Seunsangga Complex

Combining with the deck of Seun Sangga, pedestrian bridge used to connect the Seunsangga buildings over Cheonggyecheon River and Eulji-road. The pedestrian bridge above Cheonggyecheon River was taken down when Cheonggyecheon was restored in 2005, and the one over Eulji-road was taken down in 2006 when Sampung-Sangga was renovated. The deck between Sampung-Sangga and Pungjeon Hotel have been taken down, but Seunsangga Gadong, Cheonggye-Sangga, Daelim-Sangga, Shinsung-Sangga, and Jinyang-Sangga's decks are still remain.

Before they were torn down, the pedestrian bridge over Cheonggyecheon River was 10m wide and 55m long. The one over Eulji-road was 10m wide and 33m long.

- (Semi) public space on the roof top

On the top of the building roof, there are some spaces that people can share with. I consider that this place possess potentials to be improved and offer people unique experience with its spatial characteristic. Therefore, space analysis with photos is conducted in this sections.

Solar exposure and shadow study

The heat vulnerability on the street level can be assessed by the thermal sensation of building and space surfaces. In order to identify the intensity of solar exposure, the shadow patterns need to be studied. 3D SketchUP models are employed to simulate shadow patterns of the study site. In Fig.X.42, the setting information for shadow simulation is described. Cities with different geographical locations have different solar latitudes and exposure periods. This research considers the geographical conditions of South Korea to simulate the shadow patterns. Only summer shadow situations are studied, because this research will focus on implementing design measures for the hot summer time which is the most problematic season for the site area in regards to the local urban climate problem.

By simulating shadow, it was able to produce solar exposure map for four time points. By overlapping these four maps, the heat problematic maps are created as shown in Fig.X.47.

Fig.X.41 Summer and winter sun path

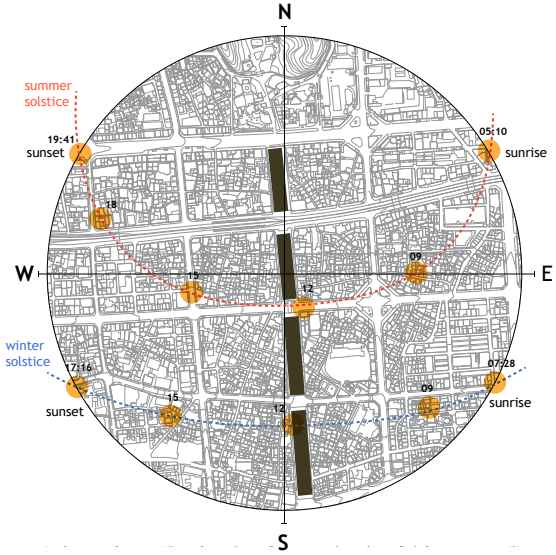


Fig.X.42 The setting to simulate the shadow pattern in the study area

Setting list	Description
Date	August, the warmest month in a year in South Korea
Time Zone	UTC+9
Time	10,12,14,16 o'clock in a day
Place orientation	North- South

Fig.X.43 Shadow simulation - entrance park

Fig.X.44 Shadow simulation - building roof

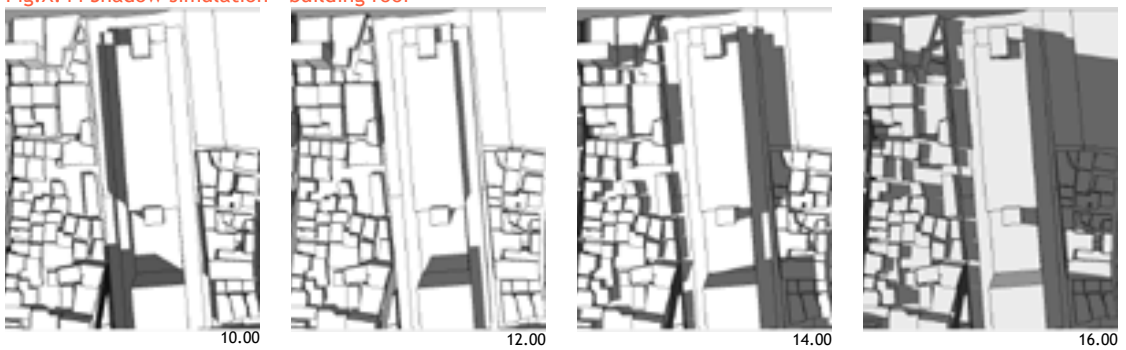


Fig.X.45 Shadow simulation - deck (west)

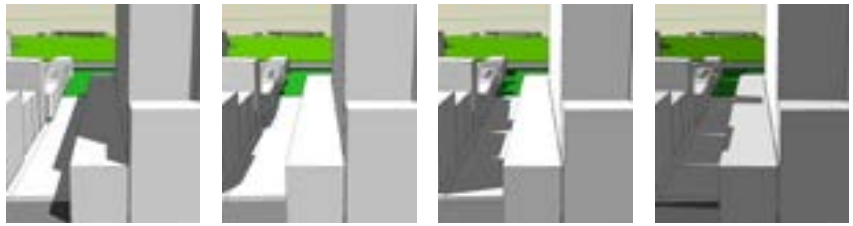


Fig.X.46 Shadow simulation - deck (east)

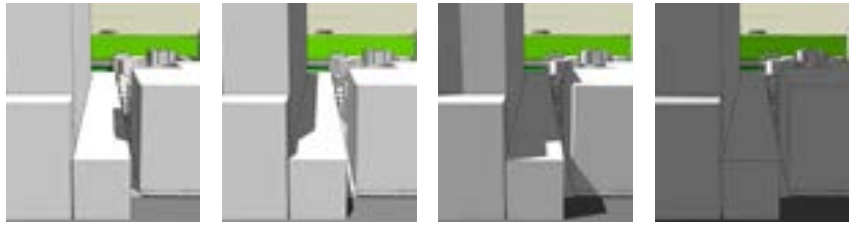
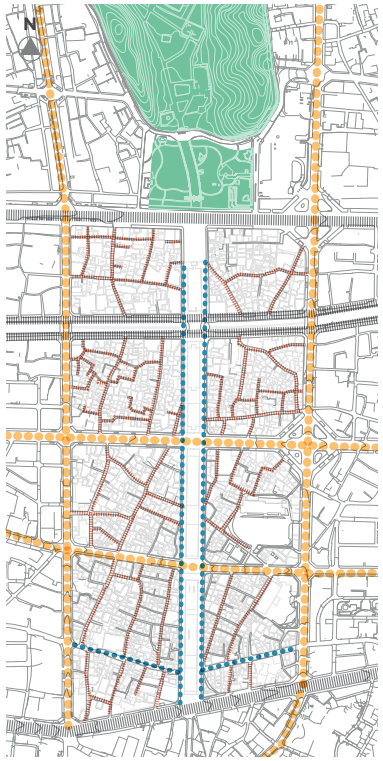


Fig.X.47 Heat intensity maps

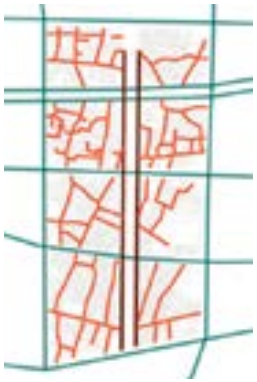
Fig.X.48 Road system in the study area



main road (6 lanes)
secondary road (4 lanes)
one lane car road
alleyway

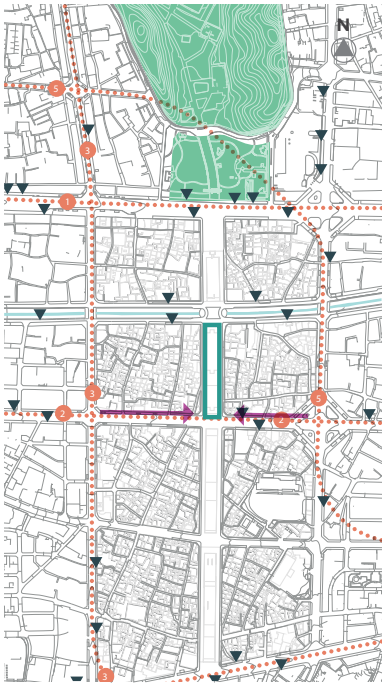
Fig.X.49 Car movement direction

Fig.X.50 Connectivity



good
need to be improved

Fig.X.51 Public transport



subway route
subway station
bus stop

Traffic systems

- Road types

The traffic system in the site area is convenient. As it shown in the traffic map (Fig.X.48), three main roads (six lanes) are built in E-W direction, and four secondary roads (four lanes) support the traffic accessibility. Compared to these two major roads in the site, one lane and narrow alleyways in immediate vicinity of Seun sangga buildings offers less convenient connection.

- Public transport

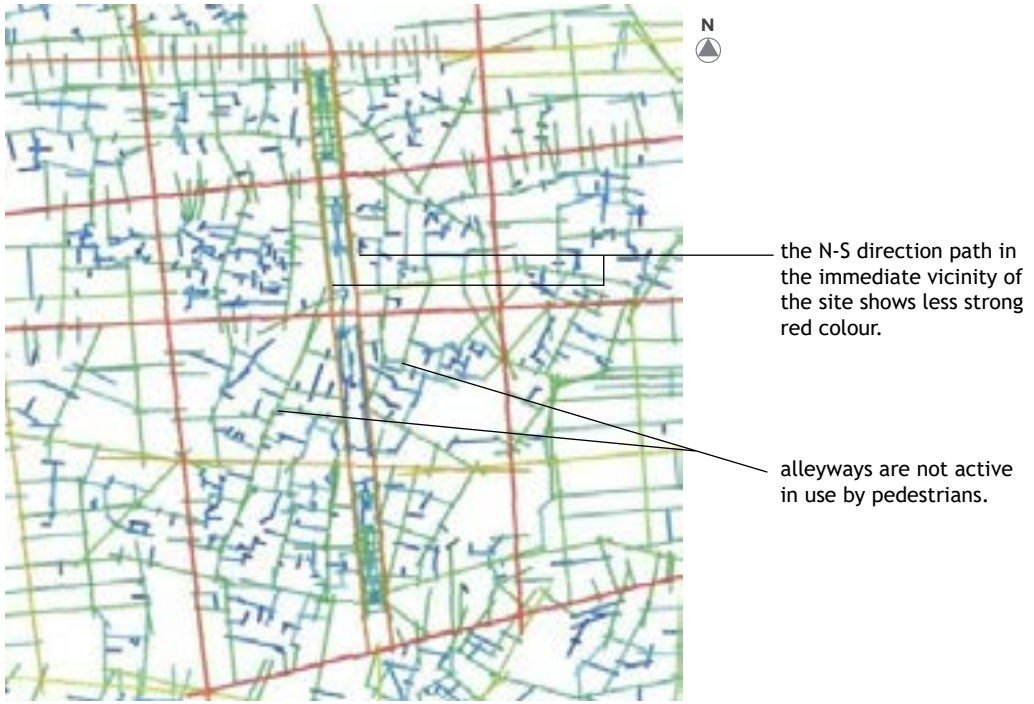
The site also has convenient public transport system like subway and buses (Fig.X.51). However, the routes from the station to the site need to be better oriented to introduce people to reach to the Seun sangga buildings easily.

Pedestrian movement

Compared to the well organized connection systems for motor vehicle traffic, the accessibility and qualities for pedestrian routes in the study site is very poor.
Space syntax resulting in local integration map is analysed (Fig.X.52) to examine the pedestrian volume and flow in the site. The integration is the focus of the axial map analysis and the values are shown using a colour map from red to purple (Ratti, 2003). The warmer colours such as red represent the most integrated paths with heavier pedestrian movement within the study site. According to the information, the North-South direction lines in the immediate vicinity of Seun sangga buildings and pedestrian decks shows less strong red colour compared to the colour of other major roads in the outside of the site buildings. This result implies the failure of pedestrian decks in active use, and the reason can be assumed that the flows of pedestrian movements in these paths are interrupting by Eeat-West direction car roads. In addition, the alleyways in surrounding districts has very little pedestrian volume because the conditions of alleyways are very poor and too narrow for comfortable walk. The giant axis of Seun sangga building structure is also the big barrier of continuous flow of the alleyways.

Therefore, immediate streets and paths should be re-oriented or improve their conditions to enhance the accessibility of pedestrians to the site. Removing barriers for pedestrians movement would be also very important to encourage their vibrant activities in streets and between buildings As a result, it even may encourage city dwellers and visitors to moderate their dependence on private vehicles.

Fig.X.52 Pedestrian movement analysis - data from Space Syntax local integration study (Lee, 2004).



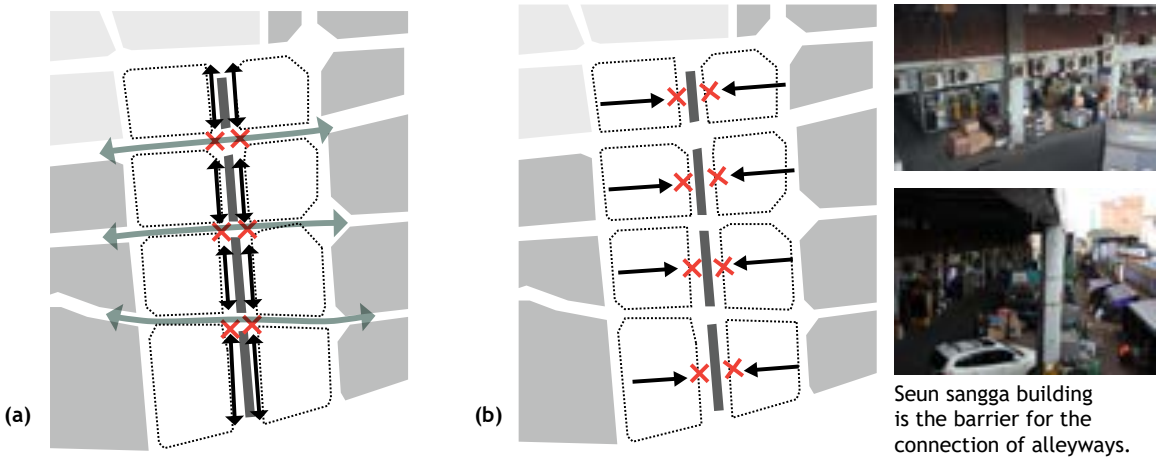


Fig.X.53 Interrupted pedestrian connection in N-S direction (a), and interrupted pedestrian connection in E-W direction (b).

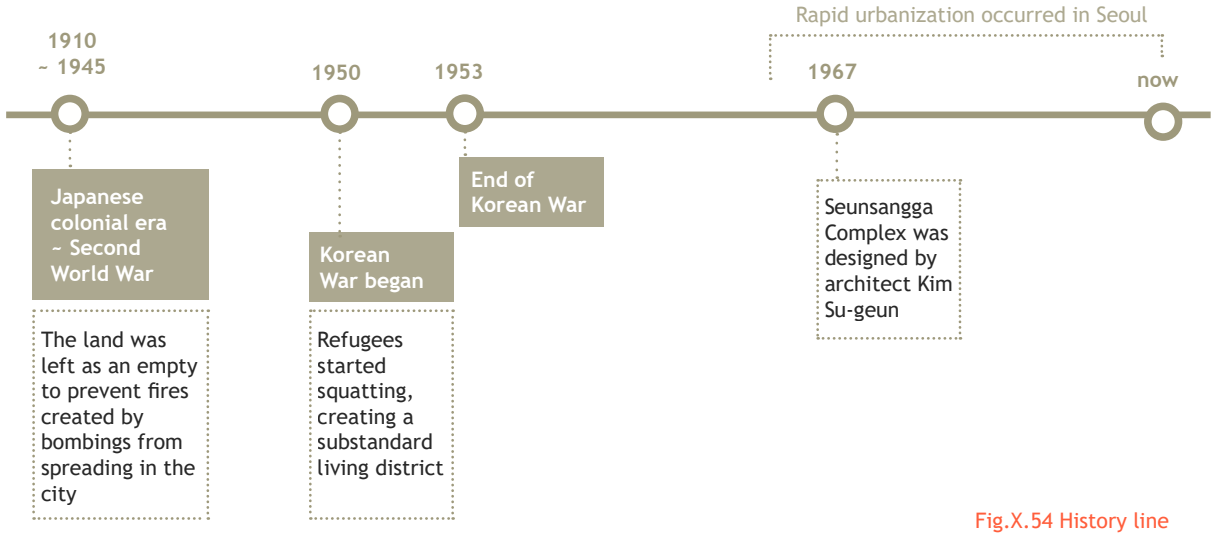


Fig.X.54 History line

Fig.X.55 Seunsangga and surrounding area in 1960's

Historical background

The current Seunsangga Complex was designed by architect Kim Su-geun (1931~1986) in the late 1960s as Korea's first downtown redevelopment project. It was a three-dimensional city that separated pedestrians and vehicles with mega-structures and artificial land that stretched from north to south. Constructed from 1967 to 1972, Seun sangga Complex was Korea's first mixed-use building that combined residential and commercial spaces as well as amenities which gained popularity among noted public figures at the time. It also has meaning in architectural history as a mega-structure building in urban area that realizes a new paradigm of post-20th century urban architecture.

Change in urban fabric of Seun district

In this section, change in urban fabric of the study area is analysed by exploring historical maps of Seoul. The old street pattern is still kept in some parts within the site and surrounding areas, but they are poorly connected. Interesting point is this street pattern was designed before cars were introduced to the city. They have non-euclidean, natural geometry which used to associate with its natural surroundings like the direction of creeks or streams.

Fig.X.56 Old maps of Seun district and urban fabric change

Demographic structure

The demography of Jung-district has been studied in this section, and two important characteristics has been found.

Firstly, elderly group are the large part of the resident population of the site area.

Secondly, it has been found that the site area is the district with the lowest rates of resident population in Seoul. There used to be a large number of residents in the early period. However, as it could not accommodate long term residents any longer due to poor access to education and other public services, this region has rapidly become slums with changes in building occupancies.

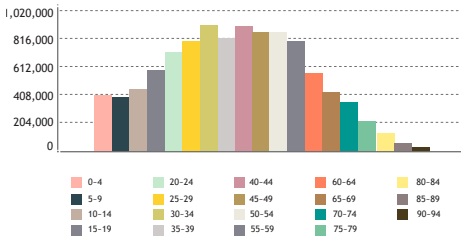


Fig.X.57 Age distribution in Jung district

Average age

- *Seoul city over all : 39.7*
- *Site area (eulgiro-dong, Jung district) : 51.3*

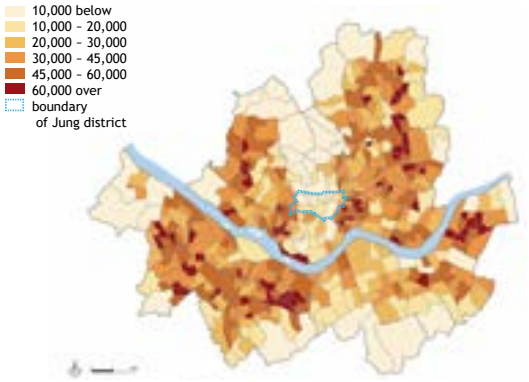


Fig.X.58 Population density of Seoul

Fig.X.59 Aging population of Seoul

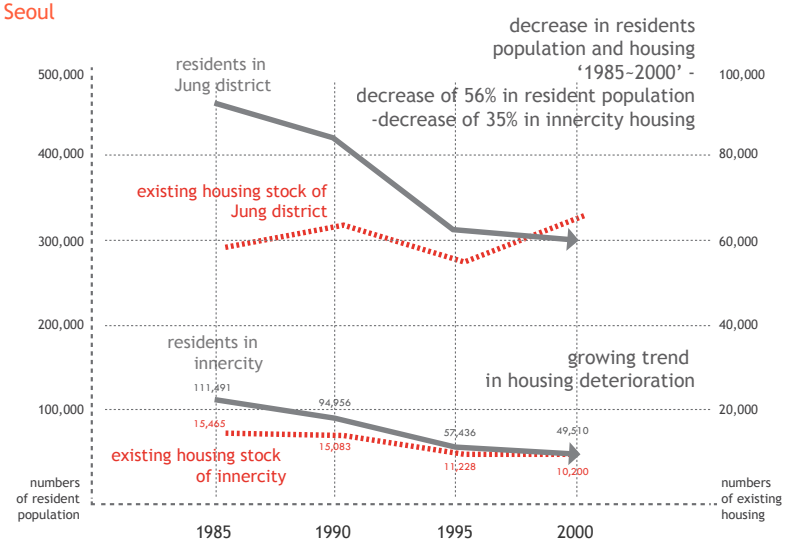


Fig.X.60 Trend of urban housing and resident population of Jung district