SAFE LIVES

Dealing with earthquake by open space in Taipei, Taiwan

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MSc graduation thesis
Alice Shu-Wen Chen #4736141

Mentors
Frits van Loon
Lei Qu

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Reading itinerary

01. *Introduction*

The introduction chapter is the first approach of this thesis and illustrates all the elements that it consists of. It starts with the fascination and follows up to the problem statements. Therefore, one main question and three sub-questions of this thesis are addressed.

02. *Methodology*

In the methodology chapter, which will explain how to develop the thesis, the overall framework gives the general idea of the main approach. Afterward, the detail frameworks are mentioned to explain the two processes of the emergency and living quality layers in chapter 3 and 4, which are followed by the layer-combining process in chapter 5, finally, the detail design in chapter 6.

03. *Emergency layer*

The development and result of the emergency layer is addressed in this chapter. Starting with the history of earthquakes in Taipei to bring up the situations this city is facing. Later, a series of the case studies and past experiences are adapted for solutions, then, on top of that, an emergency model of open space is built and applied in the city based on the analyses. Finally, an open space system proposal for evacuation during earthquakes is designed.

04. *Living quality layer*

The goal in this chapter is to develop the proposed open space system during daily life for improving citizens' living quality. First, a historical timeline of how the city has expanded is shown. Under the circumstances, it leads to negative spatial qualities in the city, as evaluated by literature reviews and a survey. Secondly, the strategies and approaches are established based on negative qualities. Finally, the chapter ends with the open space system suggestions for living quality improvement.

05. *Typology*

The design intervention aims to combine the emergency and living quality layers and develop open space system for both situations. As a result, a typology of the open space system based on the two layers is designed. Eventually, zoom in to the priority area for detail design in the next chapter.

06. Design Intervention

In this chapter, the design proposals are trying to deal with the issues during emergency and daily life. The proposal considered different aspects, including process, strategies, programs, etc. Afterward, zoom in to neighborhood scale to demonstrate the open space typology in the priority area. In the end, by combining the requirements of space during both situations, zoom in again for detailing of the open space, which provides for both better living quality and evacuation.

07. *Conclusion*

In the concluding chapter, after the completion of the design proposal through all the layers and scales, it is crucial to reflect on the whole process and understand if the research questions can be answered. Is the design able to deal with both earthquake evacuation and living quality improvement? What lessons are learned? Also, the whole design process will be concluded to propose a design guideline for further adoption.

08. *References*

All sources, related to this thesis, are cataloged in this chapter.

09. *Appendix*

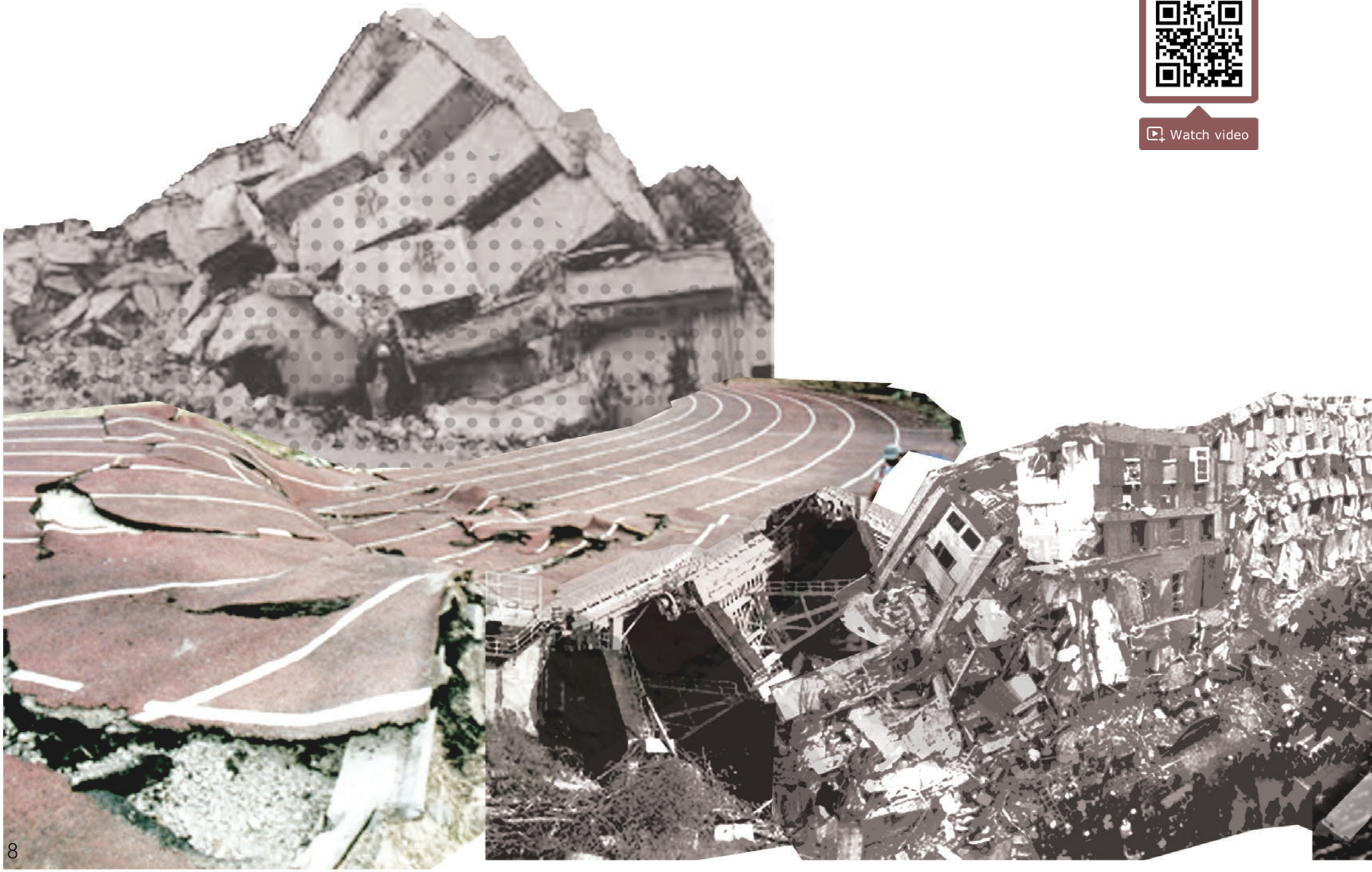
The final chapter contains additional information concerning the analyses and design process.

01

- Fascination
- Problem statement
- Research questions

INTRODUCTION

Watch video



FASCINATION

Two years ago, an earthquake happened in south Taiwan, which caused more than 600 casualties. It was the most serious loss in the past century. Since Taiwan is a new country which lacks historic records of big quakes, people were shocked and the government in other cities started being aware of this issue, especially the capital city, Taipei, which is standing on a big fault that hasn't released for the past hundred years.

I was born and raised in Taipei, one of the highest density cities amount the world. I remembered after that incident, people started panicking because they realised how dangerous the situations will be if a big quake really comes. A report even showed if an earthquake with a magnitude bigger than 6.8, will cause 12645 buildings collapse and 2968 casualties (National Center for Research on Earthquake Engineering, Taiwan, 2018).

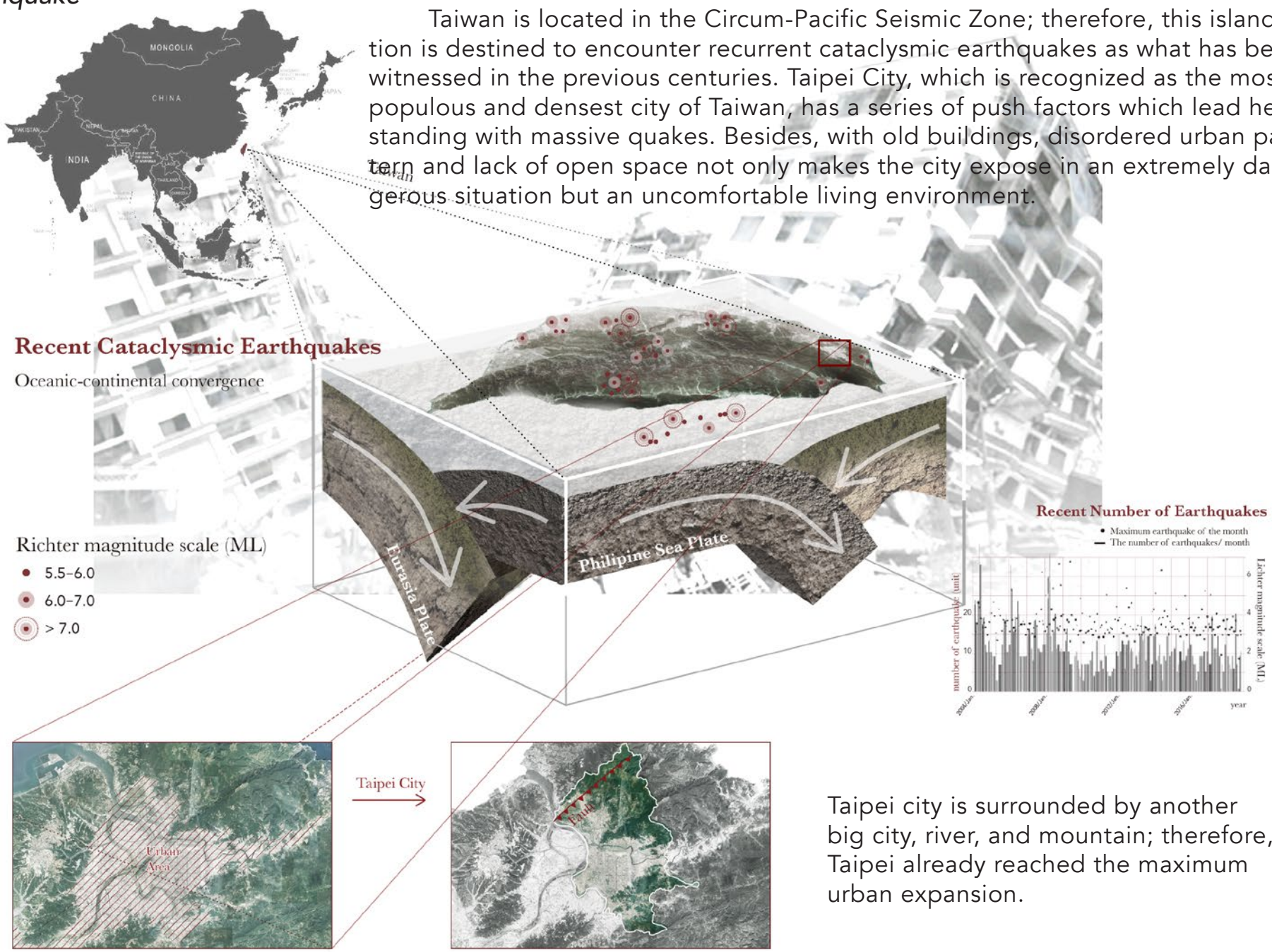
So I started thinking about how we can reduce the loss to the minimum for this sensitive city.

"How can we live safer and better?"

PROBLEM STATEMENT

Earthquake

Taiwan is located in the Circum-Pacific Seismic Zone; therefore, this island nation is destined to encounter recurrent cataclysmic earthquakes as what has been witnessed in the previous centuries. Taipei City, which is recognized as the most populous and densest city of Taiwan, has a series of push factors which lead herself standing with massive quakes. Besides, with old buildings, disordered urban pattern and lack of open space not only makes the city expose in an extremely dangerous situation but an uncomfortable living environment.

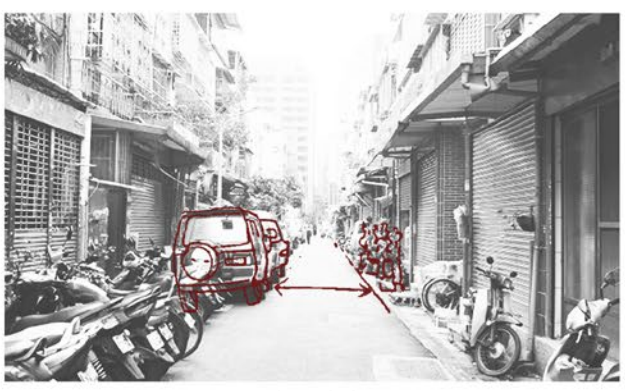


Taipei city is surrounded by another big city, river, and mountain; therefore, Taipei already reached the maximum urban expansion.

Living Quality

Busy traffic

High population



Dense buildings

RESEARCH QUESTIONS

Based on the descriptions above, the research objective of this thesis is focused on the following main question:

"What are the landscape interventions that can create a safe and livable city?"

As a result, to explore this question, three investigative questions are developed:

- What is the open space system for evacuation during earthquakes?
- What kind of open space system in Taipei City can improve citizens' living quality?
- How to combine both approaches, emergency and living quality, to create a safe and livable city?

02

- Overall framwork
- Emergency layer
- Living quality layer
- Proposal

METHODOLOGY

Image https://www.videoblocks.com/video/mountains-landscape-of-taipei-with-buildings-around-taiwan-is-a-mountainous-island-that-has-the-largest-number-and-density-of-high-mountains-in-the-world-pan-4k-hlruxcyxgiw8rdqqi

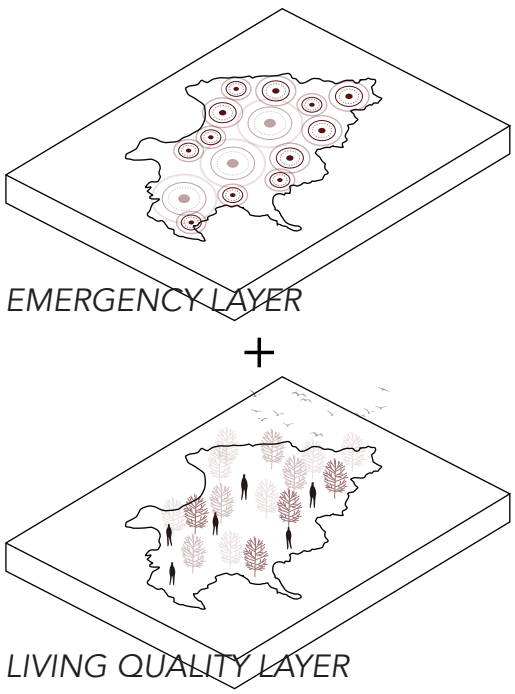
OVERALL FRAMEWORK

First, the thesis explores an open space system not only for emergencies but also for improving the living environment in Taipei by combining two situations: emergency (earthquake) and daily-life living quality:

- **Emergency layer:** In this thesis the open space of Taipei is analysed to identify the areas in the city where there is not enough open space in case of an emergency.
- **Living quality layer:** In this thesis the open space in Taipei is analyzed on the qualities for humans to live in the city and identify where public space fails to offer this in a proper way.

Secondly, for the overall framework, a design is made, which consists of a combination of both layers. The design proposals are approached on three different scales to explore how this open space system works in both emergency and daily life:

- **The city scale:** after combining those two layers, a city scale open space distribution is proposed. Then, based on it, a series of open space typologies are demonstrated.
- **The neighborhood scale:** zoom in to the priority area and visualize the open space system on the neighborhood scales.
- **The spatial design:** zoom in again to the open space and design those space for both emergency and daily life.



EMERGENCY LAYER

The goal of this layer is to analyze if the open space in Taipei is enough for people to evacuate in Taipei City, and where should be improved. Therefore, a three-steps evacuation open space model is proposed and applied on sites to assess the evacuation space in Taipei. As a result, the goal is built on the steps below:

- Understand the earthquake impact through the historical review.
- Base on the literature reviews and past experience, search for possible solutions.
- Study the current evacuation plan in Tapei and compare with the knowledge from the studies.
- Due to the evacuation behavior, a three-step evacuation system is proposed, which includes temporary gathering sites, evacuation sites, and recovery shelters with different requirements.
- Build the database based on the requirements of these open space in ArcGIS. For instance, open space, routes, population, restriction factors, etc.
- Apply the model in Taipei and zone the catchment area of each open space.
- Mark the areas which are uncovered by the open space catchment areas.

LIVING QUALITY LAYER

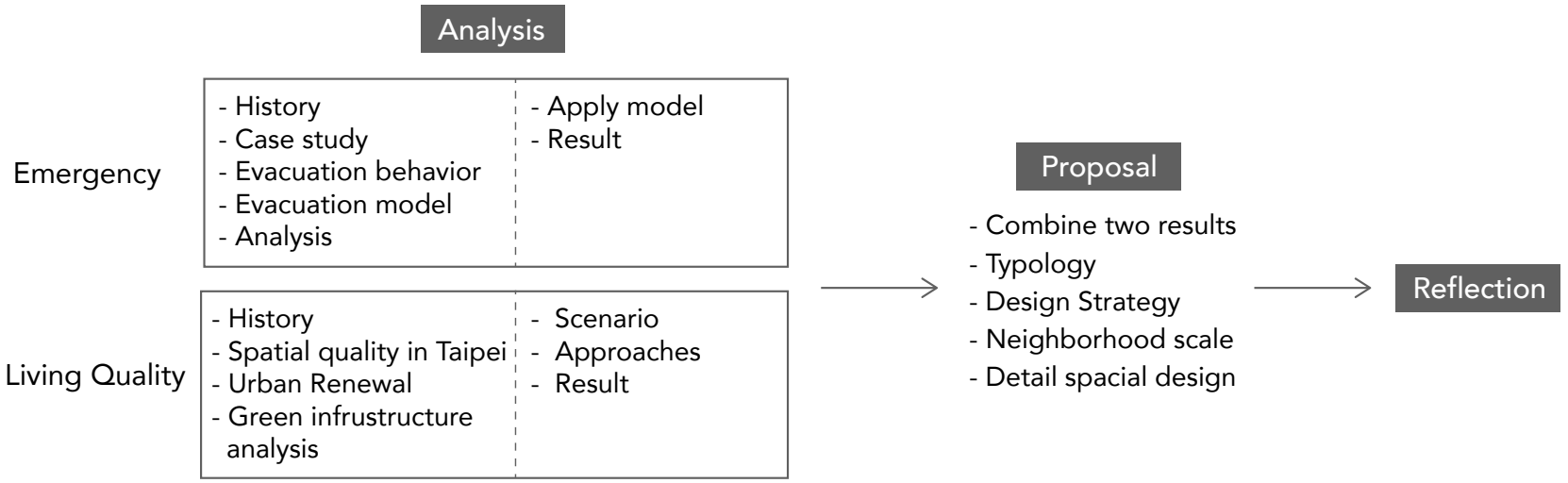
This layer aims to explore the problems in Taipei, and explain how to improve them by landscape approaches. Therefore, the proposals are achieved by following steps:

- Understand the problems of urban structures by mapping the historical maps.
- Assess the spatial quality in Taipei and list the negative spatial qualities.
- Propose the strategy, urban renewal with green infrastructure, which based on the negative spatial qualities in Taipei.
- Analyze the priority renewed area according to local laws, which target the dangerous areas such as old buildings, narrow lanes (inaccessible for fire engines) and soil liquefaction. Afterward, map them in ArcGIS to present the priority area.
- Analyze the current green infrastructures in ArcGIS and zone the less green area.
- Map the priority renewal and less green area, the results show the areas with dangerous situations and lack of green space.
- Propose the vision and address approaches.
- Conclude the results with the proposed plans.

PROPOSAL

The proposal come along with the combination of those two results, and an open space system for both earthquake emergency and daily-life time is designed by the following steps:

- Map two results from the two layers.
- Develop an open space system typology in Taipei by the combined map.
- Explore design principles for the designs.
- Zoom in to neighborhood scales to demonstrate the typology based on the design principles.
- Zoom in again to the spatial design of the open space to present the space with different functions during an emergency and daily life.



03

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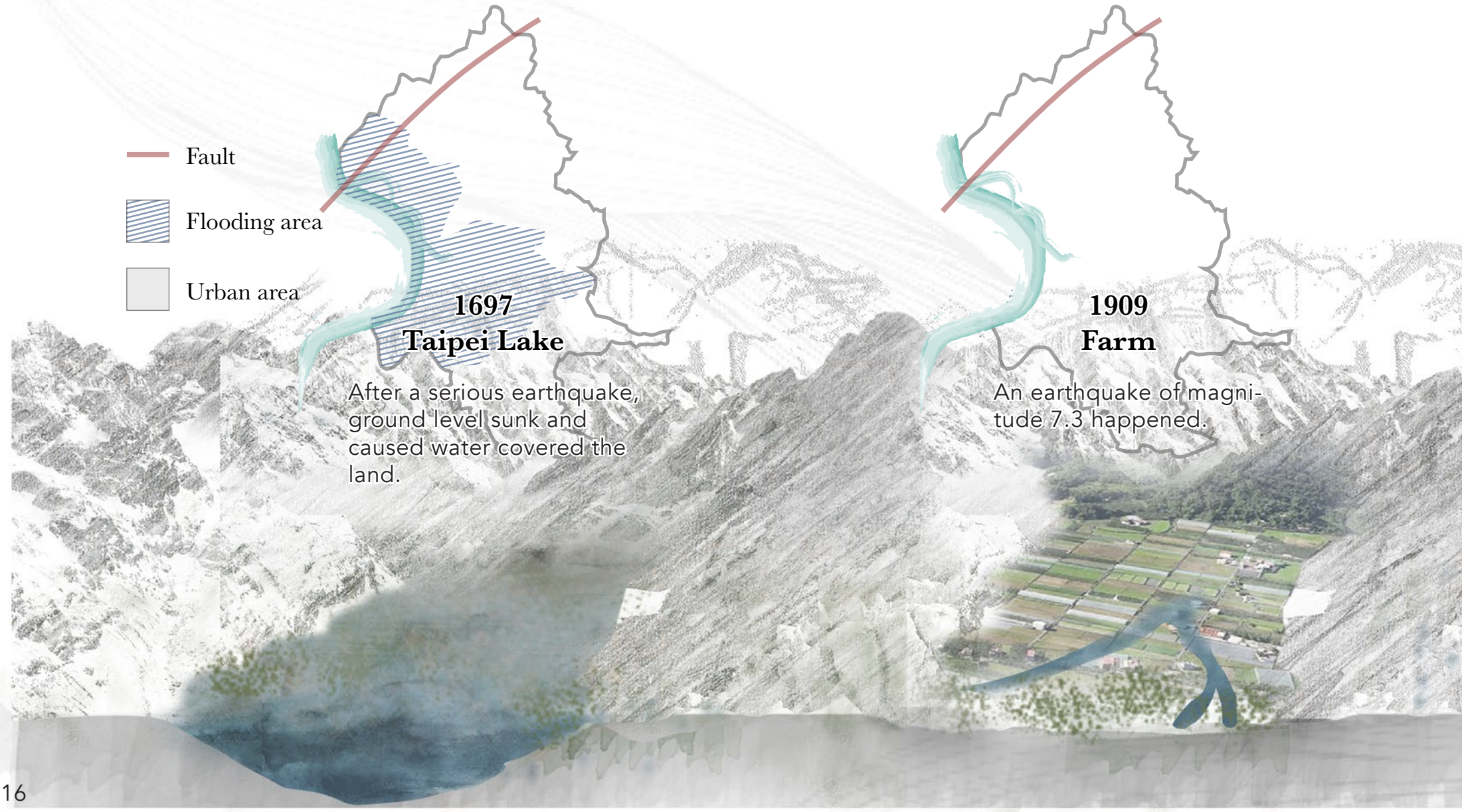
EMERGENCY LAYER

HISTORY OF EARTHQUAKE IN TAIPEI

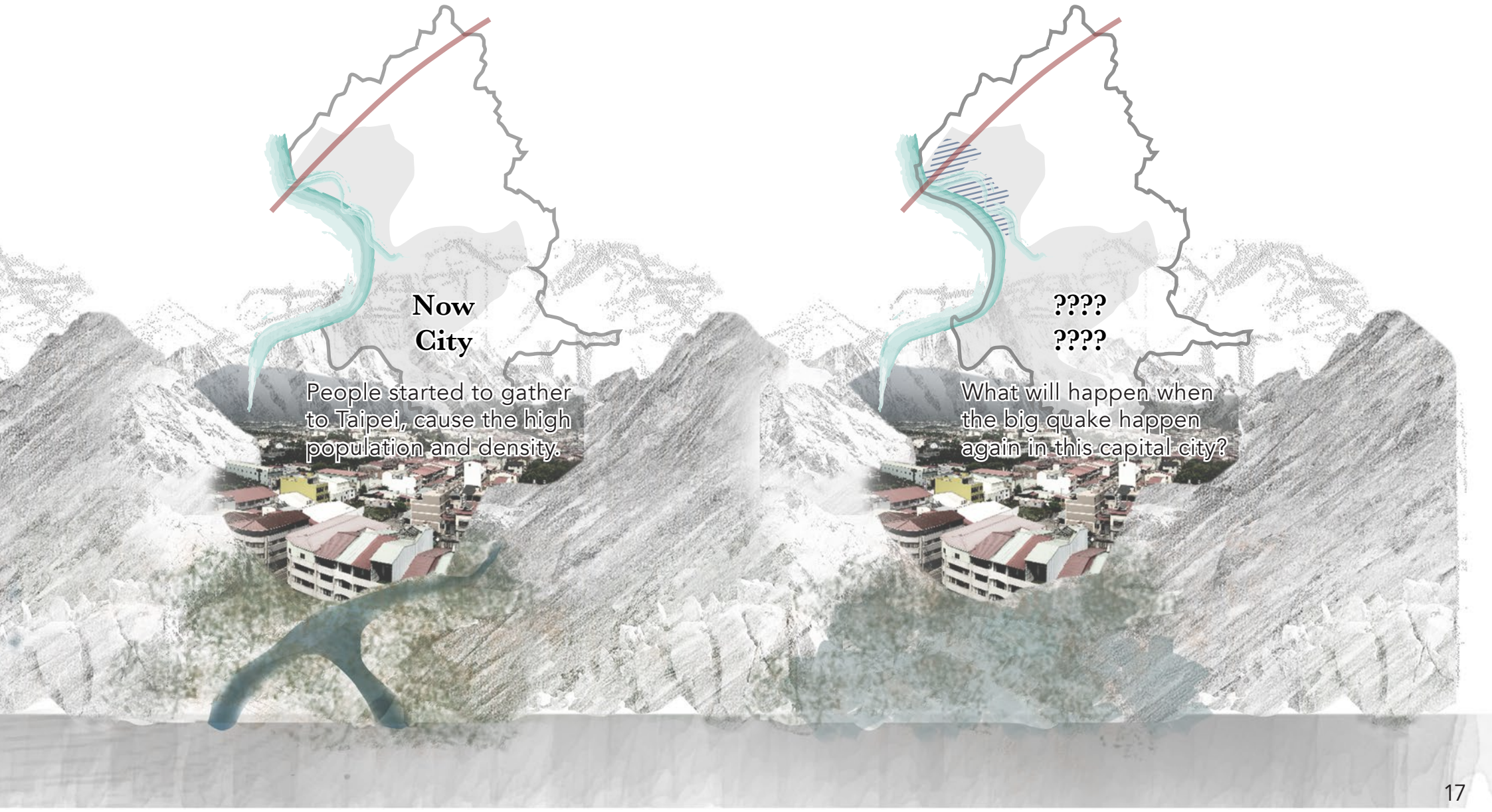


The formation of the Taipei Basin was caused by the activity of Shanchiao fault (Teng et al., 2000), which is a *locked fault*, i.e. it is not usually active and continues to accumulate energy until releasing it as earthquakes. Therefore, this type of fault usually leads to enormous quakes.

Moreover, the past researches have shown that Taipei Basin has been sunk at least 600 meters, which might be caused by the earthquakes in the past 500,000 years.

From the historical records, two major earthquakes due to Shanchiao fault have occurred. The first one happened in 1694 and it also caused the ground level to sink, thus allowing the water to cover the land and form the famous "Taipei Lake"(appendix1.1) (Hsieh, 2000). When the water receded, people had been moving in this area gradually. After hundreds of years, another quake with 7.3 earthquake level hit the land again in 1909. However, fortunately, due to the depth of the quake source and the small population in the Taipei Basin at that time, the impact was not too strong.

Until now, the Shanchiao fault has been active for at least 500,000 years, and it has created the Taipei Basin that raises about eight million people today. However, big quakes will certainly happen again in the future. Although geologists are not able to predict earthquakes so far, the government should still be prepared and minimize the loss due to possible disasters (Chen, 2015).



CURRENT SITUATION

Taipei is recognized as one of the densest cities in the world; however, unfortunately, this city is very dangerous with respect to earthquakes. A prediction made by the government estimated that if an earthquake with magnitude scale higher than 6.8 happened, it would cause 12645 buildings to collapse and 2968 casualties (National Center for Research on Earthquake Engineering, 2018).

Collaped Buildings				Casualties				
Short	Medium	Tall	Total	Mild Injury	Moderate Injury	Serious Injury	Death	Total
7491	4615	539	12645	7220	2800	1723	1245	2968

The prediction above is based on several push factors in the city, which are as followings:

- Taiwan is a new nation, therefore, people were not aware of the earthquake issues until an enormous quake happened in Nantou in 1999. That is, the buildings before the incident were rarely designed as earthquake-resistant. Moreover, reports have shown that more than 60% of the buildings in Taipei are too old and the structures are too weak to resist in case of earthquakes (Department of Statistic, 2017).

- Taipei is a basin, therefore "basin effect" (also known as site effect) should be taken into account: if a seismic wave reached the basin, the conditions of the edges of the basin were harder, and the soil type in the basin had softer sedimentary layer, the earthquake would be more threatening. In fact, the vibration period would be longer, the vibration intensity larger, and the long-period seismic waveforms more obvious (Kuo, 2018).

- The city has also a high potential for soil liquefaction problem, which commonly happens in the areas that have the combination of "sand soil" and "high groundwater level". During a certain intensity of an earthquake, it might cause the sand particles to float in the water, weaken the support of the buildings, and lead to the buildings sink or tilt (Central Geological Survey, 2017).

Soil Liquefaction | Basin Effect | High Population | Old Buildings

Evacuation Zone

The impacts of earthquakes can be divided into direct, indirect, and follow-up disasters. Direct disasters, such as architecture damage, gas pipe rupture, et cetera, happen as soon as the shaking starts. Indirect disasters are the extension of direct disasters, for example, traffic paralysis and fire. The last one, follow-up disasters, happen right after the earthquake and usually last for a while, e.g disease or health issues caused by the improper sanitary condition (Lee, 2003). Thus, a proper system of evacuation in a city is fundamental.

The Japanese government proposed a system called "Evacuation Zone" which divides cities into several zones by neighborhoods: every zone provides the required facilities (hospitals, police offices, and fire stations) and space for people who live inside. Moreover, every zone is surrounded by "fire barriers" and "evacuation roads", to prevent the fire caused by earthquake from extending and to ensure that the supplies can be transferred into the zones (Tokyo Metropolitan Government, 1996). To be more specific, every evacuation zone shall include required facilities, evacuation space, evacuation routes, and fire barriers.

Image by Tokyo Metropolitan Government

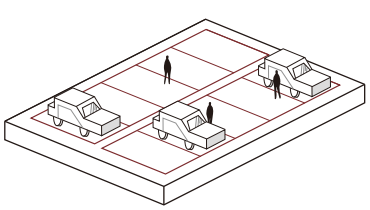
Evacuation Space

According to Japanese evacuation planning, the evacuation space can be divided into four types, associated to different periods during/after the earthquakes (Huo & Lee, 2000; Huo et al., 2005):

- Escaping site: during the earthquake, this is the place for emergency evacuation. Space is mainly open space and they should be reachable within a few minutes.
- Temporary gathering site: temporarily provide for people who can not reach the safe evacuation refuges. People here will wait for being guided to the higher-level refuges after the aftershock.

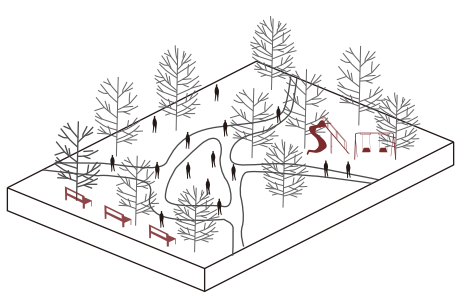
- Evacuation site: the purpose of the space is to provide a bigger area for longer stay. It also offers temporary medical aids and supplements. As a result, it shall have enough space for large vehicles and even helicopters.
- Recovery shelter: the purpose of the recovery shelter is to provide better living quality for people during their restoration period. That is, the space is usually larger than 10 hectares. Moreover, it is necessary to include more complete facilities (temporary houses for example).

According to the past earthquake experiences in Taiwan, when earthquakes happened, people usually stayed in temporary gathering site, which combined the functions of escaping site and temporary gathering site, and waited for further instructions, As a result, the evacuation space can be simplified to three types in this project as the illustrations below:



Temporary Gathering Site

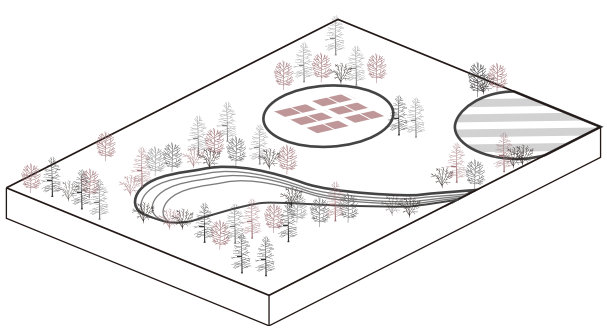
0.5 m^2/ person



Evacuation Site

More than 1 ha

2 m^2/ person



Recovery Shelter

More than 10 ha

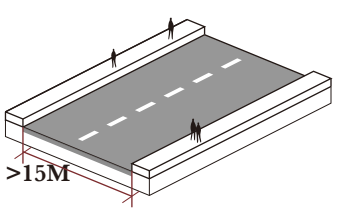
4.5 m^2/ person

Evacuation Route

To create a complete evacuation system, the connections between different space and houses are essential. According to different functions and conditions, the evacuation routes can be divided into four types (Huo & Lee, 2000):

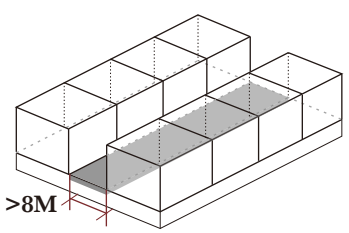
- Emergency main road: main roads which connect different districts; they are at least 20m wide.
- Transportation road: roads that connect between main roads and form the whole system for transportation and supplements; they are at least 15m wide.
- Rescue road: rescue roads should allow the fire engines to pass through during earthquakes; thus, they are at least 8m wide.
- Fire road: routes to connect different space and serve as fire barriers.

According to the descriptions above, the temporary gathering site should at least connect to the rescue road system; while the evacuation site and recovery shelter should connect to the transportation road system.



Transportation road

More than 15m



Rescue road

More than 8m

Group Evacuation Speed

An important parameter for the analysis is the evacuation speed. Since almost all the people will evacuate during earthquakes (group evacuation), the evacuation process is slower than the usual running/walking speed.

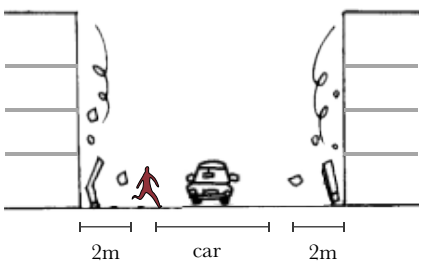
In order to understand the speed of group evacuation, Ho et al. (1999) did a series of researches and surveys. Their result, represented in the following formula, is that the speed during group evacutions is similar to the speed in metro stations during rush hours:

$$V=1.32-0.34D$$

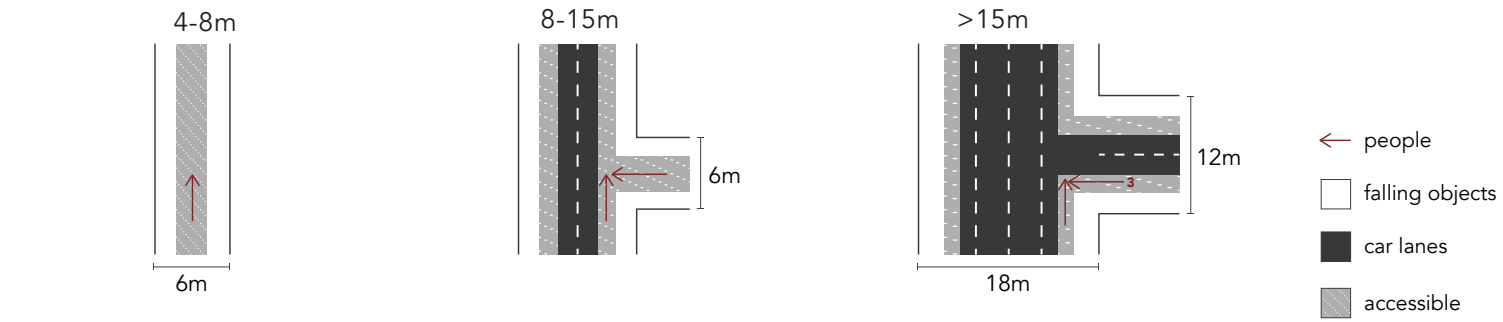
(V=speed, m/s ; D=density, person/m^2)

However, with different road widths and situations, the speed should be different as well. Under the circumstances, the speed based on the formula and the road width is calculated as illustrated below:

1. Consider the road with the range of 2m buildings' falling objects (Lee, 2003).



2. Hypothesize people live on the near two floors has the possibility to reach at the same time.
3. Main roads should also be considered about the population from the intersections with other roads.



4 (people)* 2(floor)* 2 (side) / 8m (house width)* (6-2-2)m(road width) = 1 person/m^2

4 (people)* 2(floor)* 3 (side) / 8m (house width)* 1m (pedestrian) = 1.5 people/m^2

4 (people)* 2(floor)* 4 (side) / 8m (house width)* 2m (pedestrian) = 2 person/m^2

4. The final conclusion of the relationships between road widths and speeds is as the table:

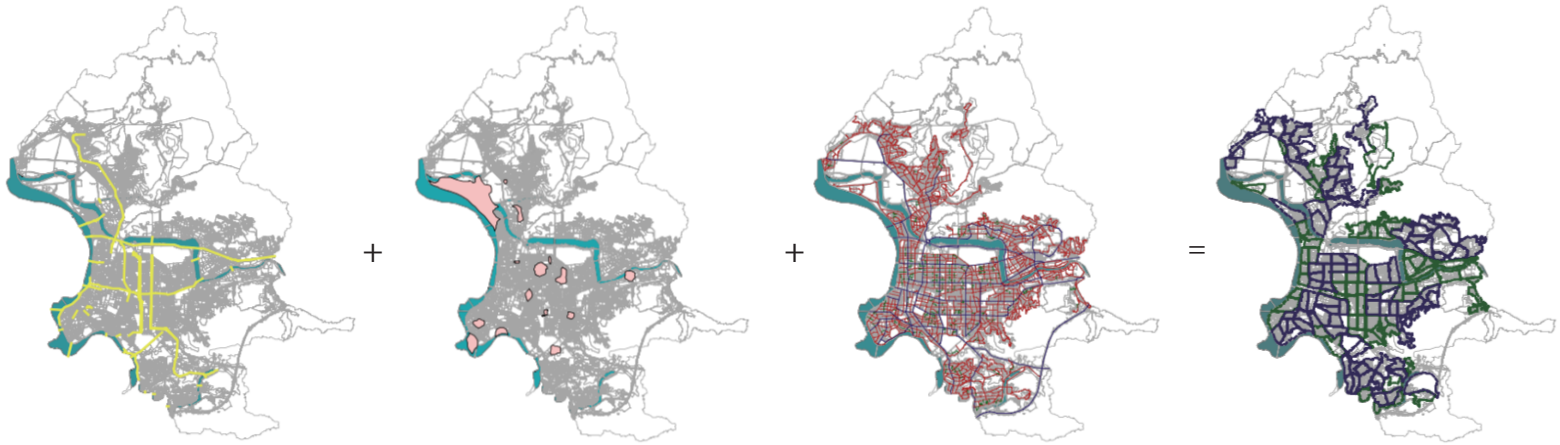
Width (m)	D (/m^2)	V (m/s)
<4	Inaccessible	
4 - 8	1	0.98
8 - 15	1.5	0.81
>15	2	0.64

CURRENT EVACUATION PLANNING

Evacuation planning in Taipei

Learning from the evacuation planning in Japan, Taipei government therefore started planning evacuation zones in Taipei City. The process was conducted as below (Huo & Lee, 2000) :

- First, the planning started from the analyses of restriction factors in Taipei City, including natural boundaries (mountains and rivers) and possibility disconnections (highways and bridges).
- Second, the main evacuation space shall avoid soil liquefaction area, moreover, buildings' structures shall be strengthened in these areas.
- The evacuation roads were labelled as different functions (width).
- Last, after mapping all the informations, zone the evacuation zones in Taipei City. In this case, every zone should be served for 30000-45000 people, and the evacuation space is mainly schools since schools are the most evenly distributed public space in the city. Afterward, the zoning system has two types in this planning: direct zone and indirect zone:
    - Direct zone: in these areas, people can reach a space, which more than 1ha, within 1km.
    - Indirect zone: in these areas, people cannot reach any space more than 1 ha within 1km. Thus, people should wait in a safe place until the aftershock ends, then they will be guided to the evacuation space.



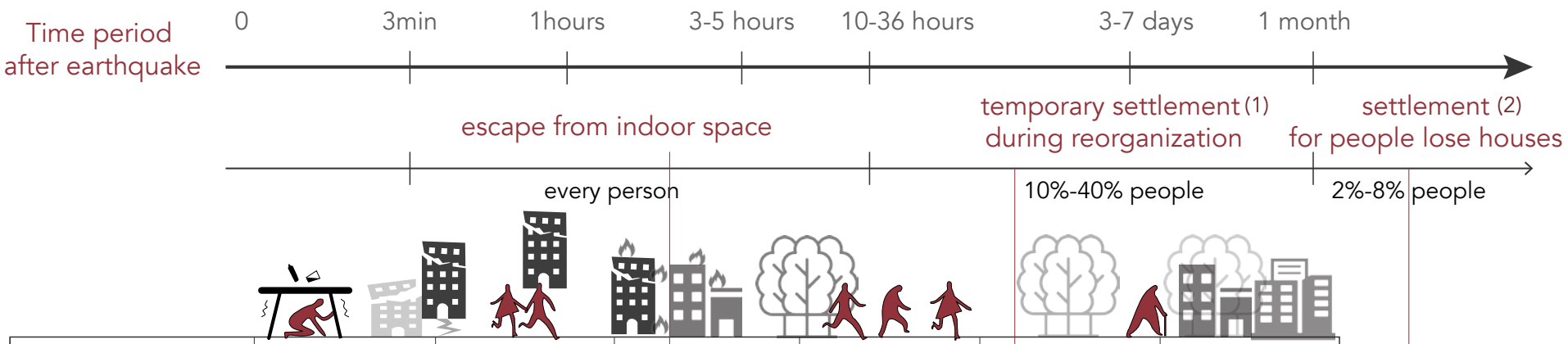
Restriction factors | Soil liquefaction | Road system | Evacuation zones

Critics of the planning

- It is not realistic to only use the open space more than 1 hector as evacuation space, since while earthquakes happen, people tend to escape to the closer space, rather than the bigger ones.
- There is no further explanation about the solutions for people who live in indirect zones.
- It was considered only one step evacuation, which is not fit to people's evacuation behavior.

EARTHQUAKE EVACUATION BEHAVIOR

By studying the evacuation behavior of people and combining the literature reviews, the evacuation space can be divided into three types, according to different periods during/after earthquakes:



period	shock	aftershock	evacuation	rescue	settlement	reestablishment
phenomenons	- buildings collapse - casualties - traffic disturbance	- aftershock - fire - buildings collpse - Emergency measures	- fire expansion - evacuation action - information disorder	- fire expansion - casualties growth - assemble people	- fire fighting - resources transportation - settle refugees	- rebuild the buildindings and facilities

Note:

(1) Predicted Population of Evacuation Site

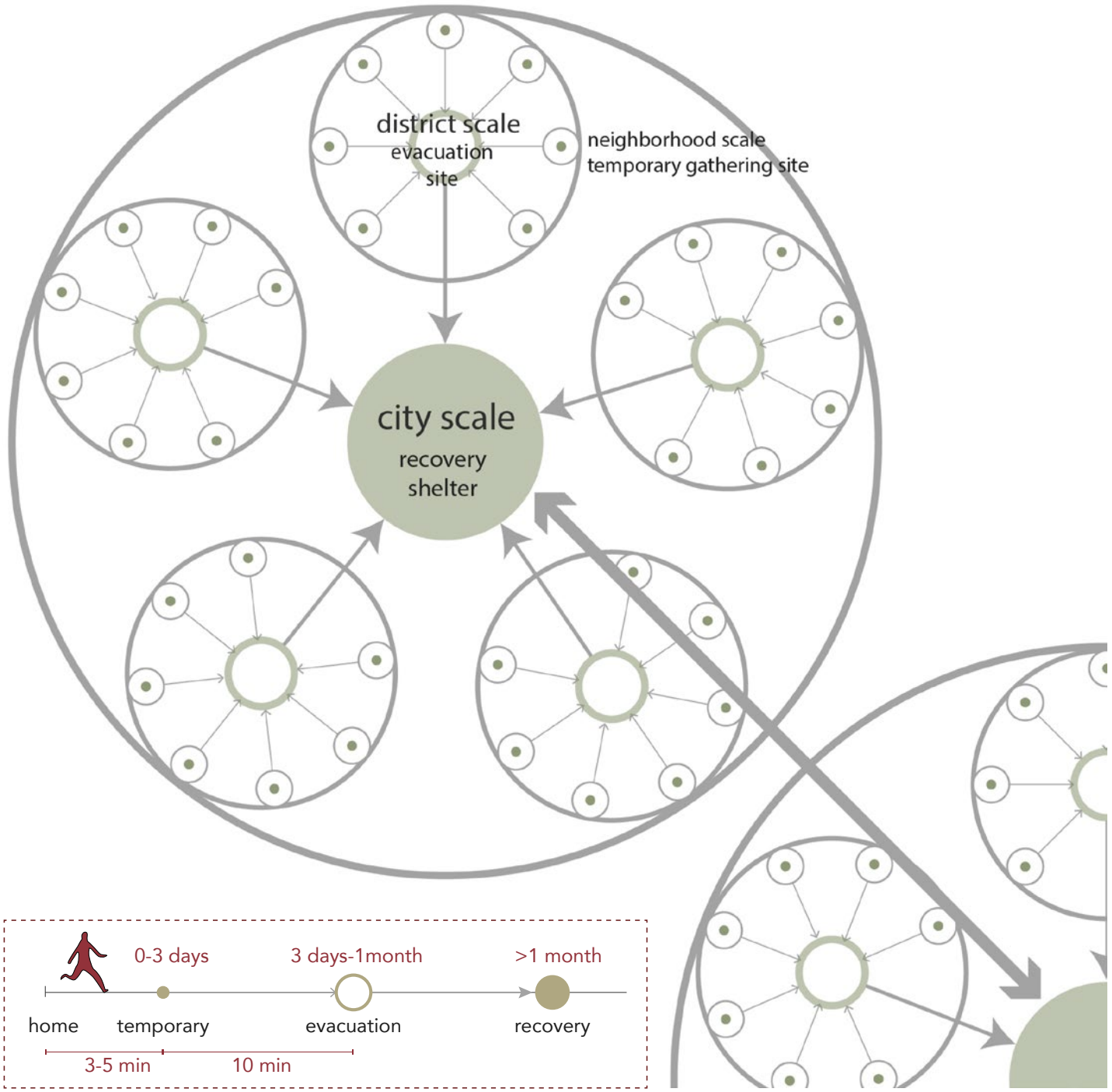
Between 3 days to 1 month after the earthquake, the frequency and scale of the aftershocks were smaller, some residents returned to their homes, or rely on relatives/friends temporarily. As a result, the number of people needed to be settled has plummeted. Based on the records of the enormous quake in 1999, the average proportion of people who need refuge during this period is 11.43%, and the maximum is 37.08% (Lin, 2007).

(2) Predicted Population of Recovery Shelter

As the prediction from the government, there will be 2%-8% buildings collapsed after an earthquake with a magnitude scale more than 6.8 (National Center for Research on Earthquake Engineering, 2018).

EVACUATION MODEL

After the findings above, the three types of evacuation space and their catchment areas can be concluded as the model below:



Temporary gathering site(0.5m²/person) :
type: tents/shelter
catchment area: 3-5 min

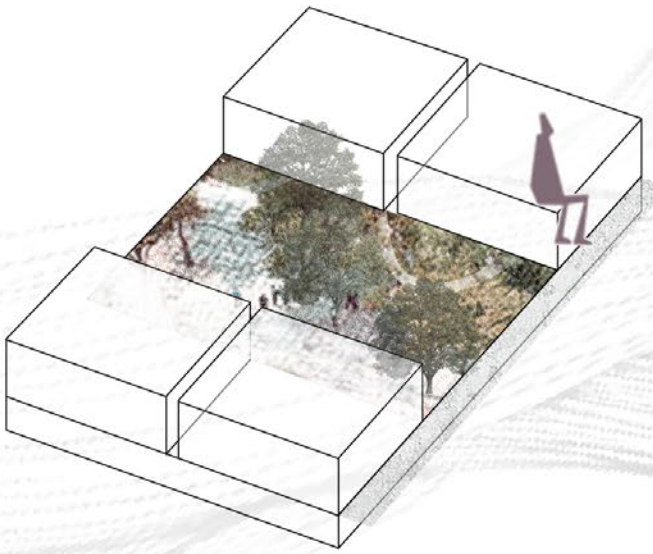
Evacuation site (>1ha ; 2m²/person) :
type: tents
catchment area: 10 min

Recovery site (>5ha ; 4.5m²/person) :
type: temporary buildings
catchment area: the whole city

Rescue road (>8m) :
Accessible for fire engines
(consider the collapsed buildings)

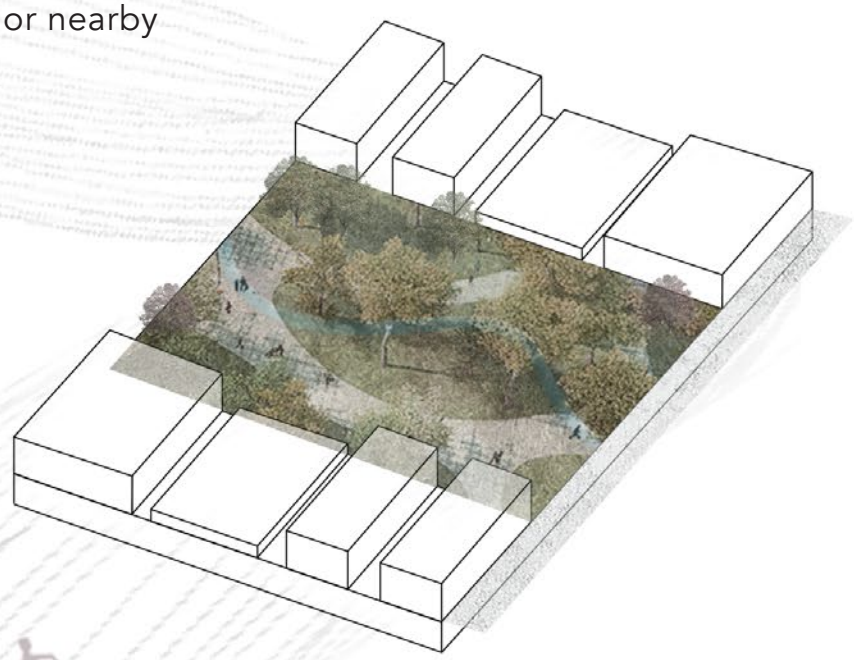
Transportation road (>15m) :
Accessible for huge amount of
suppliments

Space Requirement



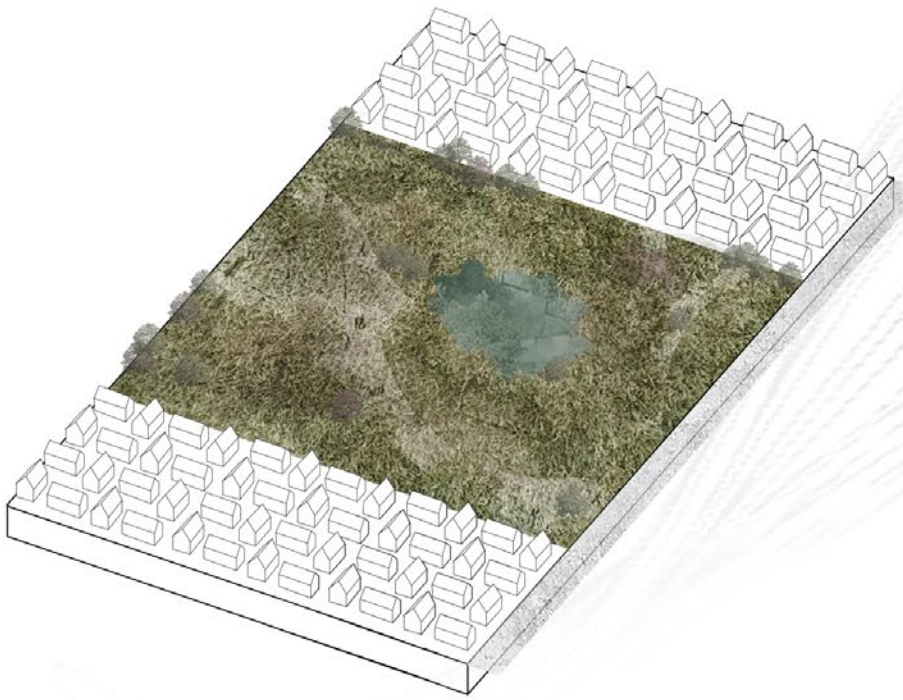
Temporary Gathering Site (0-3days)

- Space type: park, school, parking lot, plaza, military camp, industrial park
- Reachable in 5 min (group evacuation speed)
- Connect to a network >8m (for vehicles)
- > 0.5m^2/person
- Have water inside or nearby



Evacuation Site (3days-1month)

- Space type: park, school, parking lot, plaza, military camp
- Reachable in 10 min (normal walking speed)
- Connect to a network >15m (Supplements for more people)
- Evacuation space > 1 ha ; > 2m^2/person
- Have water inside or nearby; better to have police office nearby



Recovery Shelter (>1month)

- Space type: park, plaza
- Connect to a network >15m (Supplement for more people)
- Evacuation space > 10 ha ; > 4.5 m^2/person
- Have water inside or nearby; better to have police office nearby

Note:

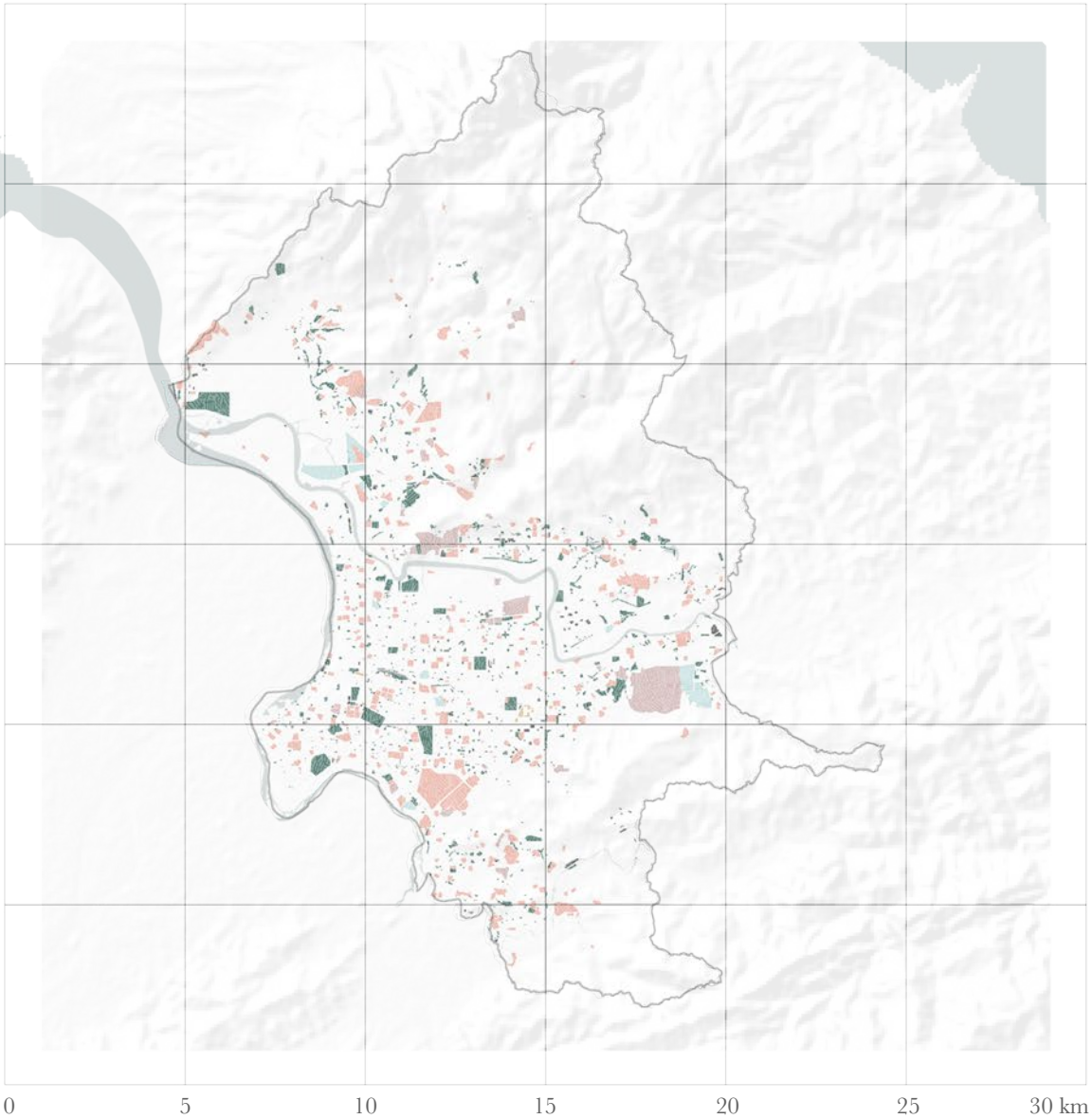
1. Industrial parks are private properties, so they are not considered as evacuation sites/recovery shelters.
2. After 1 month (recovery period), schools, parking lots, and military camps should return to their normal functions, so they are not considered as recovery shelters.

SITE ANALYSIS

Open Space

According to the past earthquake experiences in Taiwan, while earthquake happened, people usually escaped to open space such as parks, schools, plazas, parking lots, and military camps. Moreover, there are few large industrial parks in Taipei, so the potential evacuation space is as illustrated below.

However, while an earthquake happens, the buildings or facilities might collapse as well, so sometimes the open space cannot be 100% available. As a result, Hsiao & Chang (2002) did a research about the average percentage of open space that can be used after quakes. Their conclusions are documented below.



open space and the percentage of evacuation area:

park

school

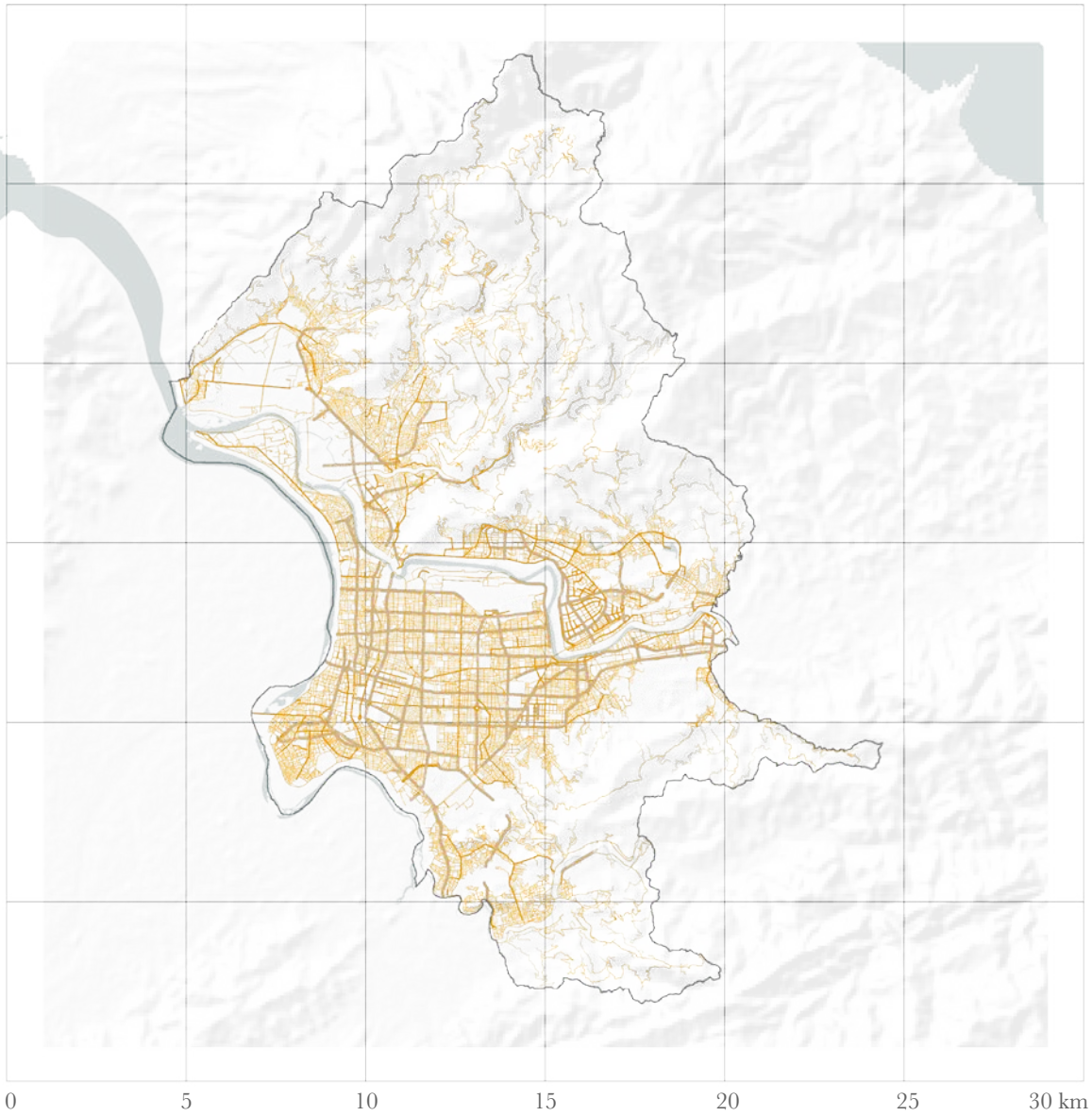
plaza

parking lot

industrial park

military camp

Road System



Based on the requirements of evacuation space, the functions of the roads depend on the widths, which can be divided into four different types.

road widths and the functions:

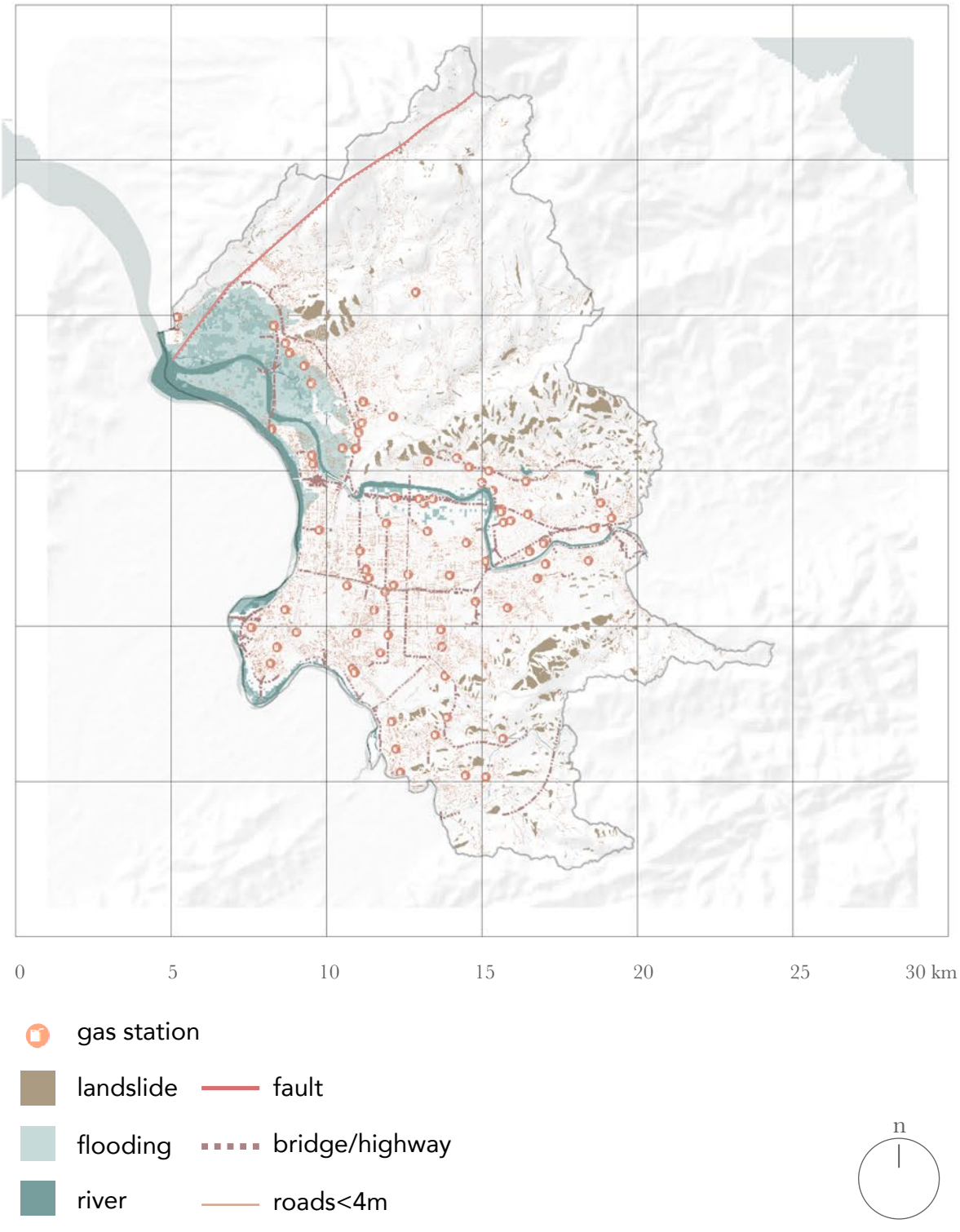
>15m : mass supplements transportation

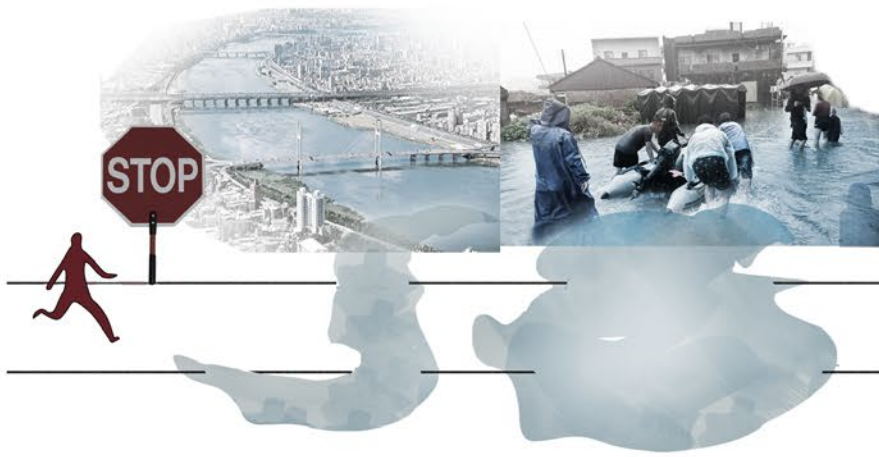
>8-15m : minimum width for vehicles after quakes

>4-7m : accessible after quakes

>4-7m : inaccessible after quakes

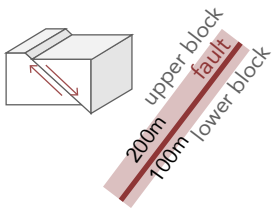
Restriction Factor





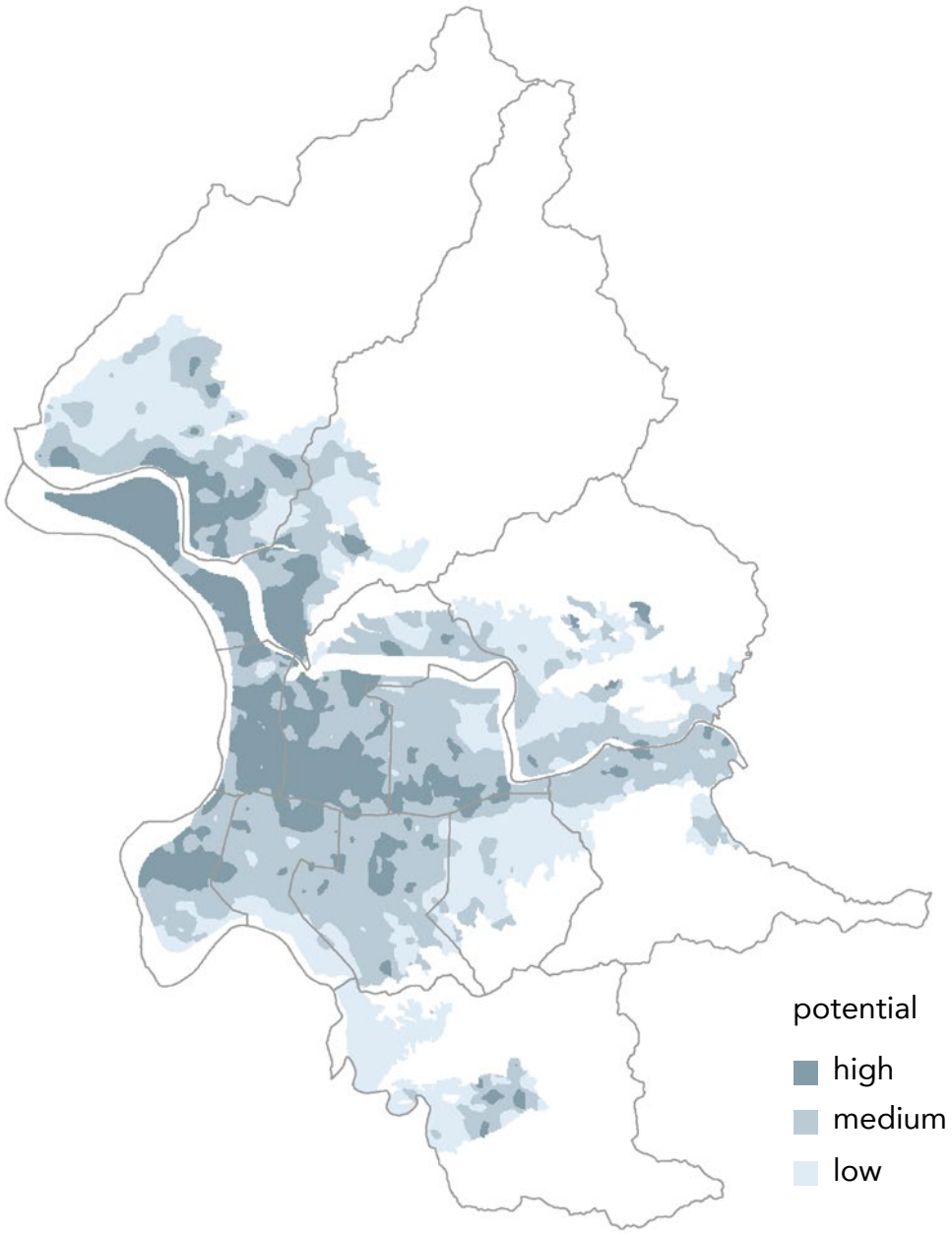
	River	Flooding by quake
area/ buffer zone	located area	land lower than 2m
Description	Natural boundary	Land might be sunken for 2m if an earthquake with Richter magnitude >6.5, and might cause the water fill in and flood the area. (Chu et al., 2008)

The factors might block the road during the evacuation.

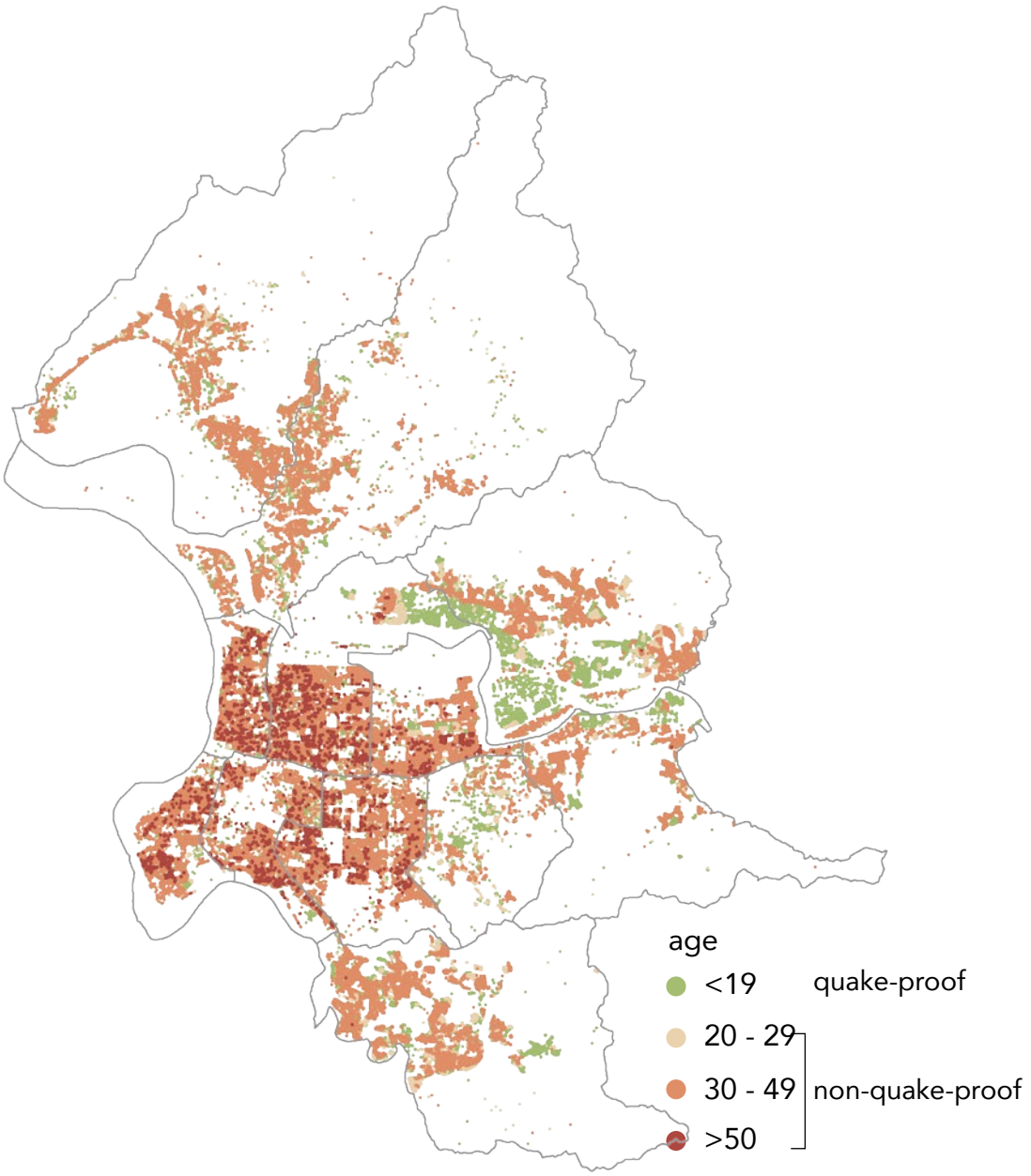
	Bridge/Highway	Road width <4m	Fault	Landslide	Gas station
	buffer zone 1m	located area	upper block 100m lower block 200m	dip slope mostly	buffer zone 5m
	Bridges or highways might collapse and block the road after quakes.	Narrow roads have higher possibility to be blocked by collapsed buildings. (Jain, 2000)	The boundary between plates, which might cause huge gaps during quakes. (Central Geological Survey, 2016) 	Locations are based on Taipei City prevention websit.	Might explode after a big quake. (Beijing administration of work safety, 2008)

Risk Potential Area

Soil liquefaction

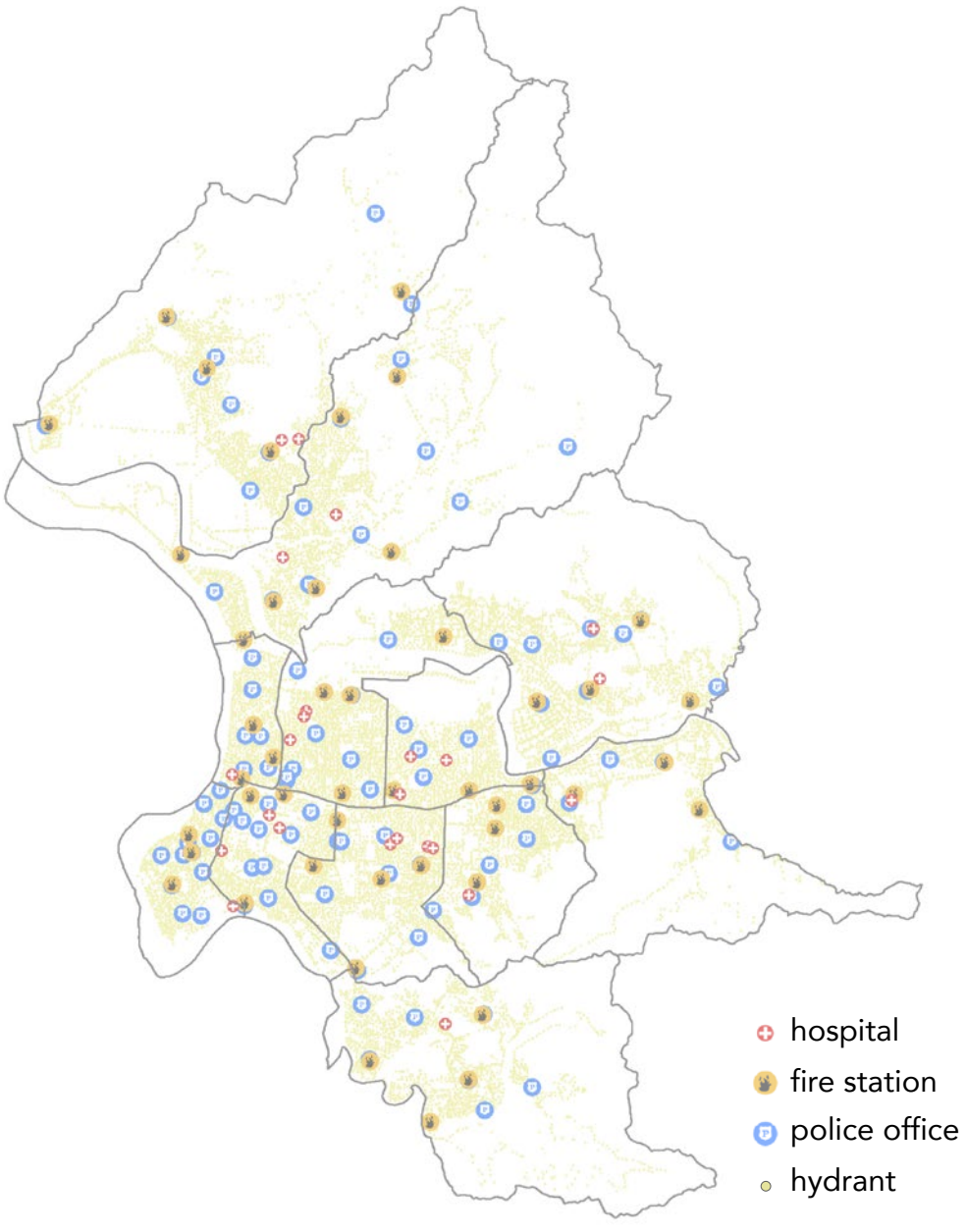


Building age

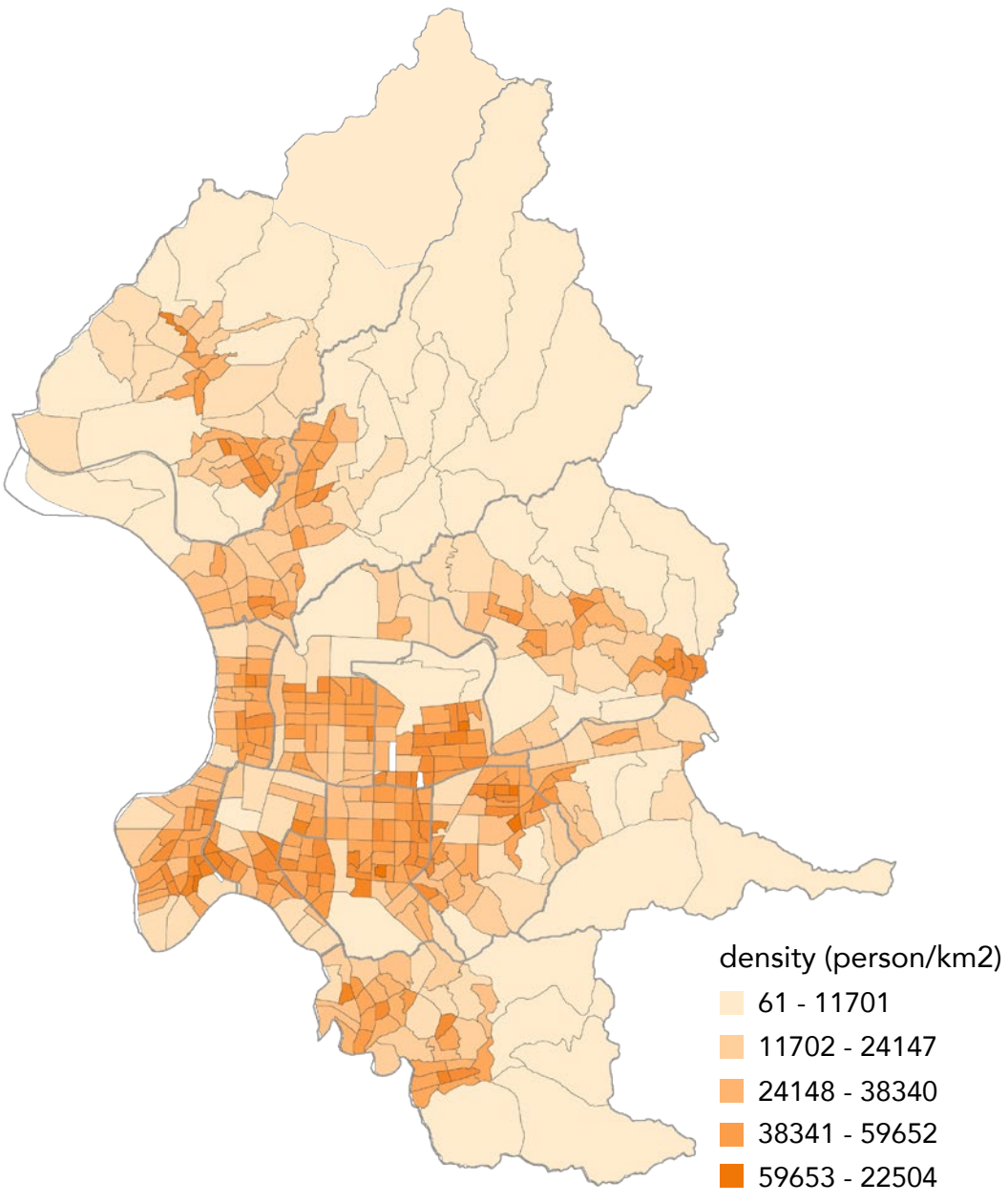


Others

Facility

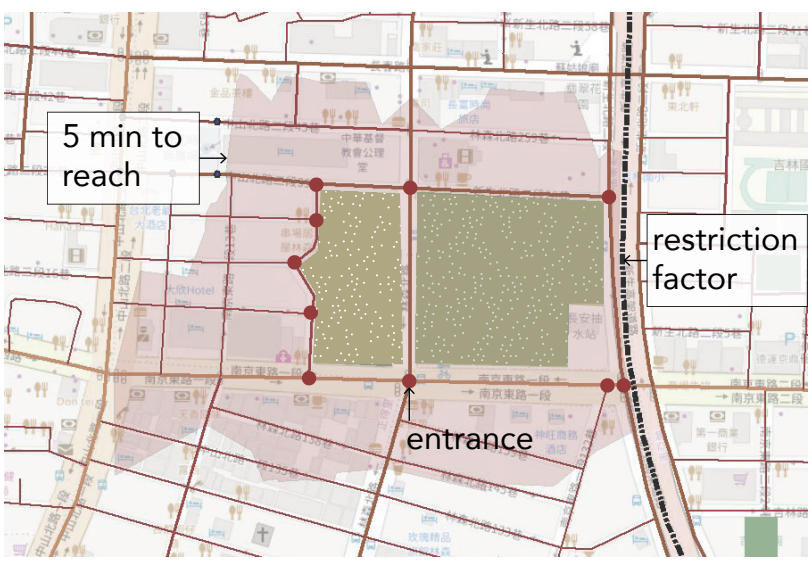


Population



APPLY EVACUATION MODEL ON SITE

Temporary Gathering Site



To define the catchment area of the evacuation space in the city, the analysis data are applied and calculated in ArcGIS. The process is discribed below (take temporary gathering site as an example):

1. Focus on the urban area where people live.
2. To find the catchment area, apply the open space entrances as the centers, five minutes distance with group evacuation speed (mentioned on p21.), and restriction factors on the command "Service Area" in ArcGIS. The result is as the diagram on the left, which create a catchment area around the open space and be cut out by restriction factor. Also, examine if the open space has required facilities nearby.
3. To make sure the open space is enough for the people in the catchment area, apply the population in the catchment area and time the required area for a person (population*0.5), then compare them with the evacuation area of the central open space (park, as an example, area*0.7). Afterward, if the required area is bigger than the evacuation area, shrink the area by the percentage((area*0.7)/(population*0.5)*100%).
4. If the service areas are overlapped, divide them by neighborhood boundaries, which are easier to manage for each unit.

Urban Area →

Open space
- park
- school
- parking lot
- plaza
- military camp
- industrial park

Facilities
- >8m width road
- hydrant

Restriction factors
- river
- flood by earthquake
- bridge
- road< 4m
- fault
- landslide
- gas station

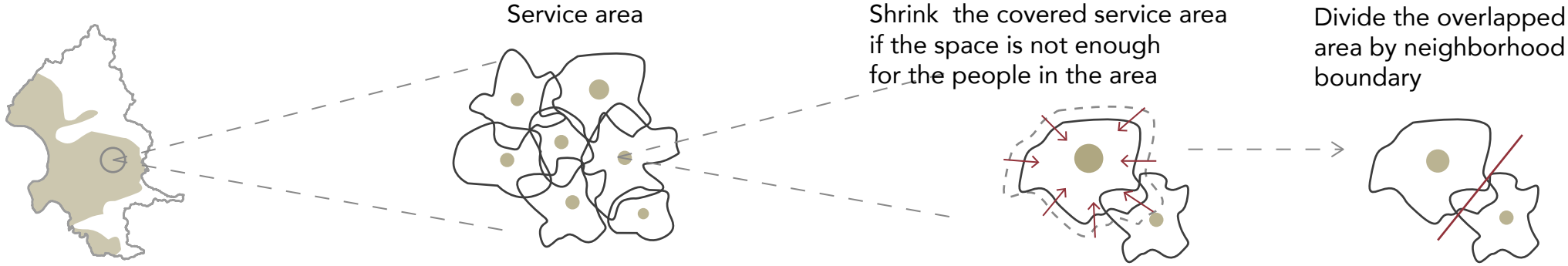
5 min to reach

Road speed:
Group evacuation speed

→ **Population** ($0.5m^2$/person) → **Neighborhood boundary** (easier to manage)

evacuation area of openspace:

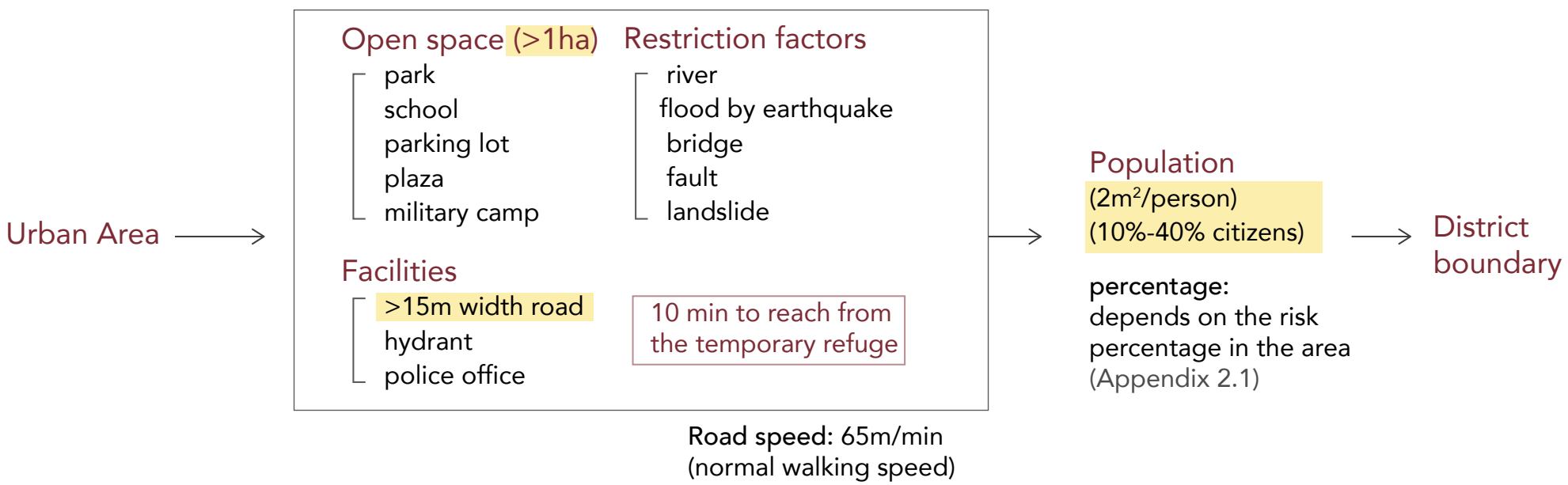
park	70%	parking lot	50%
plaza	70%	military camp	20%
school	50%	industrial park	20%



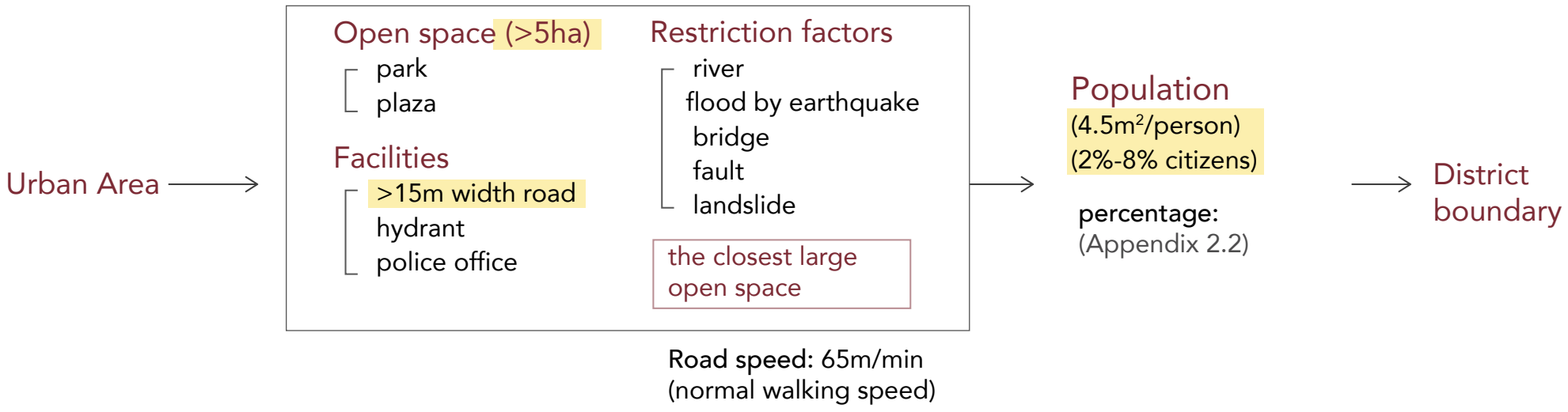
In the "evacuation site" and "recovery site", the processes are slightly different as highlighted below. Also, the road speeds in these types are normal walking speed since they are used after the quakes.

Moreover, in these types, not all the people will need to evacuate, the population is based on the prediction percentages and applied to the risk potential percentage. (The detail calculation is in appendix2.)

Evacuation Site



Recovery Site



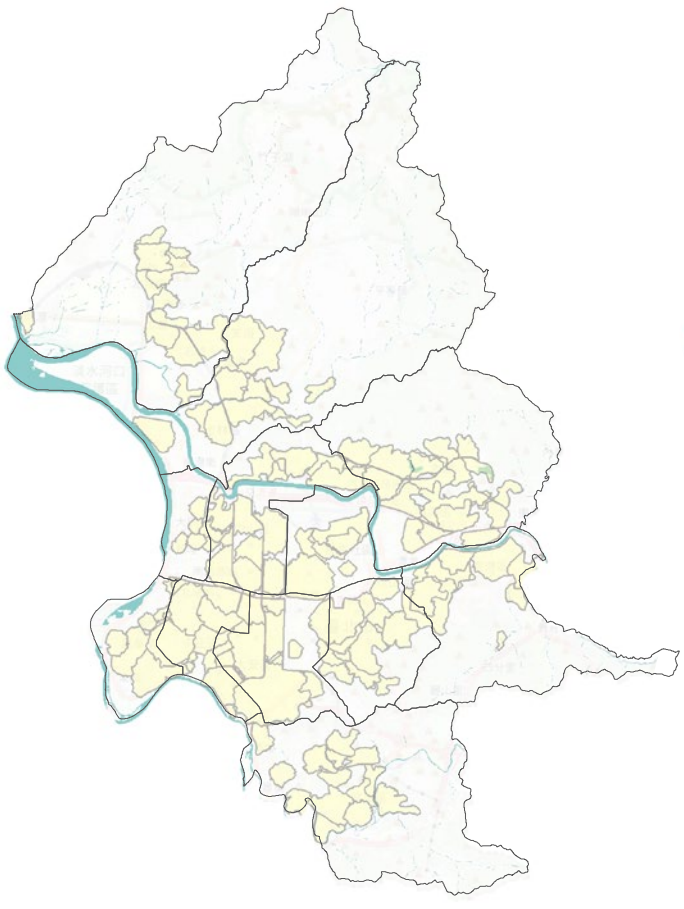
RESULT OF THE LAYER

Catchment Area

After zoning all the catchment areas, some areas are not covered by the temporary gathering sites and evacuation sites, while all the areas are covered by the recovery shelters.

Temporary Gathering Site

Evacuation Site



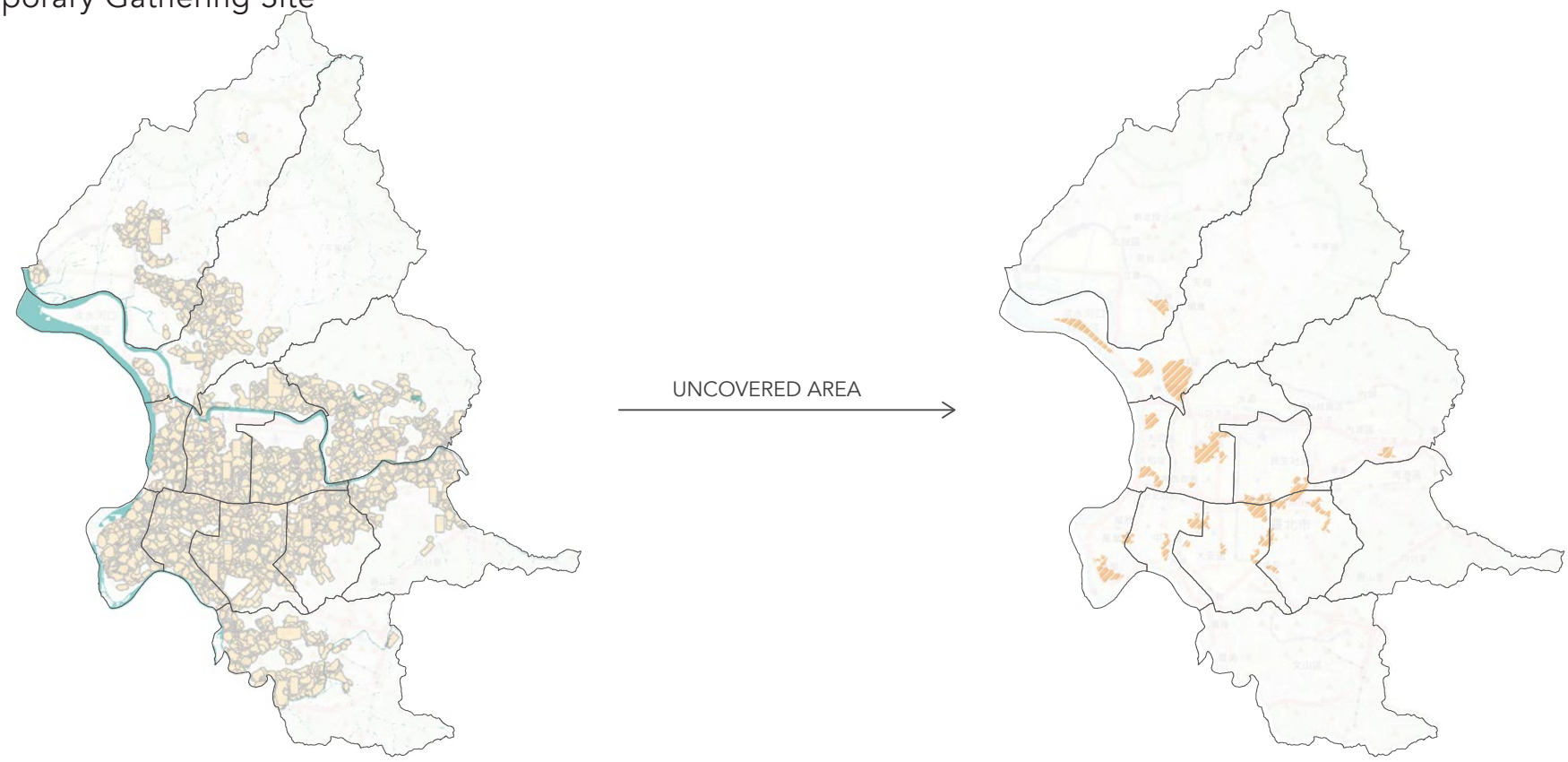
Recovery Selter

Uncovered Area

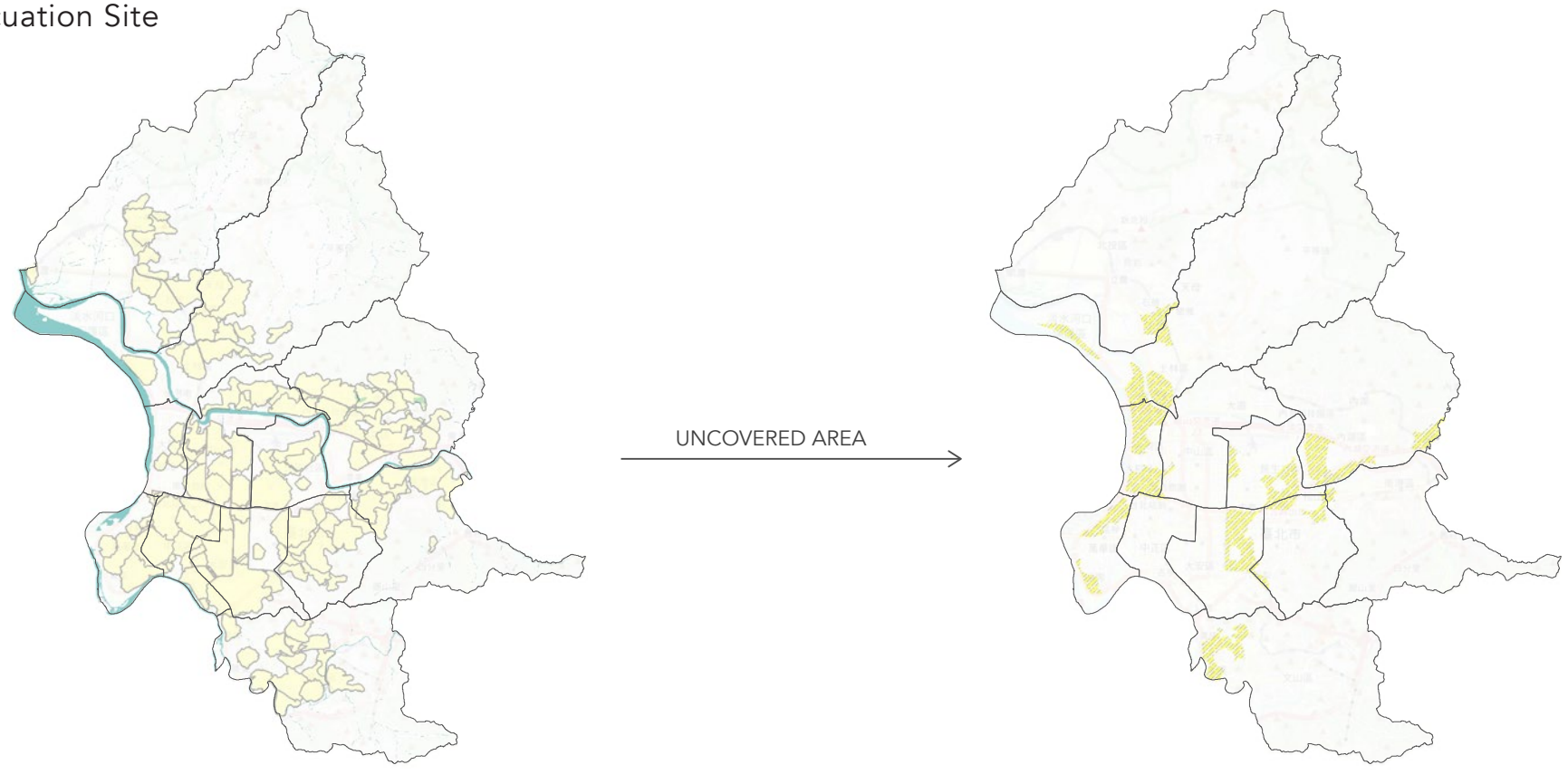
The images below show the uncovered areas, which mean people who live in these areas do not have enough open space during/after quakes.

As a result, the aim in the next chapters is to focus on the solutions to improve these uncovered areas.

Temporary Gathering Site



Evacuation Site



04

- History of urban development
- Spatial quality assessment
- Strategy
- Urban renewal priority analysis
- Green infrastructure analysis
- Proposed area
- Vision
- Result of the layer

LIVING QUALITY LAYER

Apart from the emergency functions, the main purpose of open space in a city is to improve citizens' living quality and release the stress in daily life.

As a result, the goal of this chapter is to explore how and where should the open space system be improved in Taipei City.

Image from https://jp.taiwan.net.tw/m1.aspx?sNo=0003090&id=2254

HISTORY OF URBAN DEVELOPMENT

Taiwan is a new country which was dominated by different governments in the last centuries. In short, this island nation has never been at peace. Therefore, though there were a couple of urban plannings in Taipei City before, the immigrants were more than it was expected and the city expanded too fast due to the changing of the governments. On top of this, the frequent wars in the region made it harder to execute the planning. Moreover, since it was a new country, people were not aware of the severity of natural disaster on this island until the enormous quake in 1999.

As a result, the history has led to the negative conditions in Taipei nowadays: disordered city patterns, illegal and old buildings with weak structure etc., which affect not only the safety but also the livability in the city. At the meanwhile, the city had been growing and occupying more and more space until it reached the maximum and could not be expanded more.

In conclusion, the past mistakes of urban development pose significant challenges for the improvement of the city. In particular, how can we deal with these problems and make Taipei a better place?

1905s
Taipei city can accommodate about 150000 people.

1932s
- 4 times planning area than before.
- >8m^2 green space per person.

1946s
- Planning industrial , commercial, and residential areas.
- complete green space system

1999s
Urban Renewal Act for narrow lanes and old buildings' area

1683-1895 Qing China

1895-1945 Colony of Japan

1945-1949 China

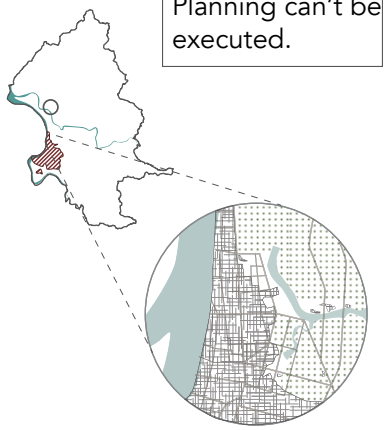
1949-now Taiwan

World War Two
Planning can't be executed.

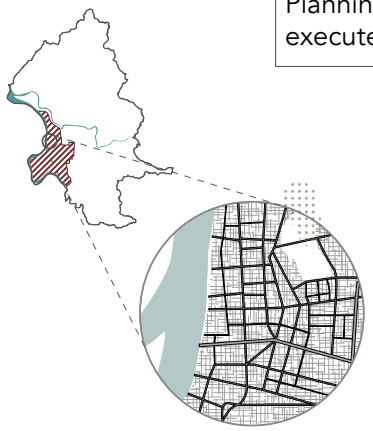
Chinese Civil War
Planning can't be executed.

1999 earthquake
Urban Renewal and buildings' structures started bing awared.

City was form around the port.



City expanded too fast, houses were exceed planning's area.



Enormous amount of people move in from China, urban structure was destroyed.

Reach the maximum population and built-up area.

Due to the wars and gorverment changing, Taipei has a lot of illegal houses causes chaos in the city.

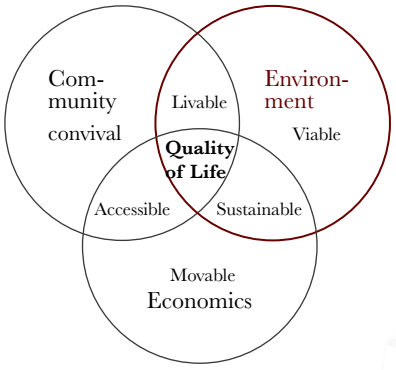
SPATIAL QUALITY ASSESSMENT

To improve the "living quality", it is essential to investigate the living quality in Taipei first; therefore, a survey is adopted.

In order to design the questionnaires, several well-known living quality assessment models, related to environmental factors are applied. The models include:

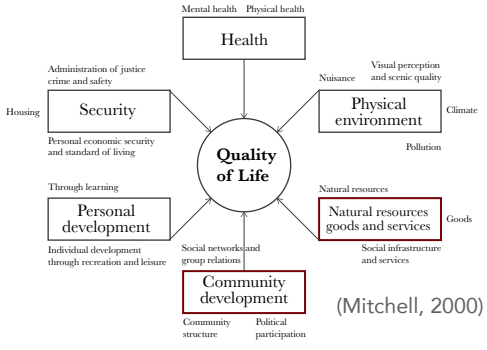
1. A conceptual model of factors that contribute to community quality of life from a human ecological perspective by Shafer et al.
2. Domains of (human) livability and (environmental) quality-of-life by Kamp et at.
3. Quality-of-life components by Mitchell.
4. Spatial quality assessment matrix by Dauvellier & Luttik.

Besides, along with the general living quality questions, for further spatial design, a few questions about open space are also included in the survey.



(Shafer et al., 2000)

(Kamp et al., 2000)



(Mitchell, 2000)

	Economic profit	Social profit	Ecological profit	Cultural profit
User value	Accessibility, fine-tuning of functions	Public access, participation	Ecological gradients, structure	Water fronts, diversity
Future value	Attractiveness, image	Safety, Connectedness	Tranquillity	Beauty, contrast, individuality
Amenities	Stability, flexibility, safety hinterland	Public support for change, responsibilty	Environmental friendly materials, robustness	Cultural heritage renewal

(Dauvellier & Luttik, 2003)

Evironmental Relevent
Living Qulity / Spatial Quality

Tools:
Questionnaire
Relevant Research

Questionnaire

Basic Information:
gender/age/where do you live?

Part1 Urban Infrastructure and Service

- Are you satisfied with the current transportation system in Taipei City? which one is the most dissatisfied?
- Are you satisfied with the amount of parks and open space in Taipei (excluding mountain area)?
- Are you satisfied with the public participation systems of urban planning?

Part 2 Built Environment

- Are you satisfied with the architecture and cityscape of Taipei? why?
- Are you satisfied with the pollution situation in Taipei? If not, what kind of pollution?
- Do you feel safe in Taipei? If not, what could be the possible reason ?
- Do you think there is something else need to be improved in Taipei City besides the above questions? why?

Part 3 Urban Open Space

How often do you use urban open space?

What are the activities you do the most in an open space?

What is the time of preference for going to the open space in a day?

Do you have any other suggestions for the public open space in Taipei?

Survey Statistic

206 responses

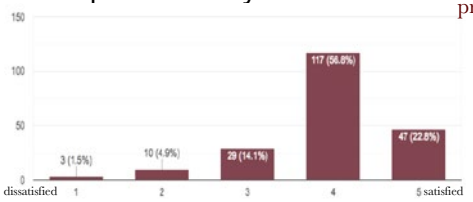
The following results are collected by Google Forms, which have 206 responses.

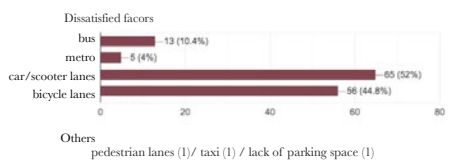
Besides, due to some of the living quality factors can't be evaluated by the survey, the literature reviews are served as supplements.

Urban Infrastructure and Service

Transportation system

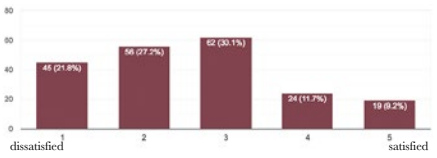
mostly satisfied (70.8%)
problems: car/scooters lanes (52%); bicycle lanes (44.8%)





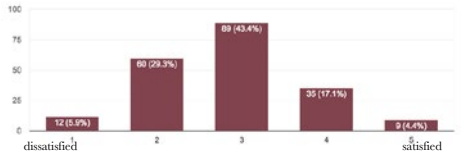
Open space quantity

mostly dissatisfied (49%)



Public participation

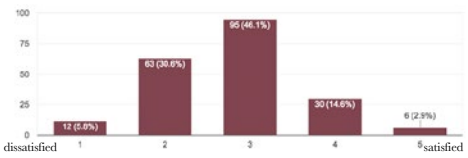
slightly dissatisfied (35.2%)

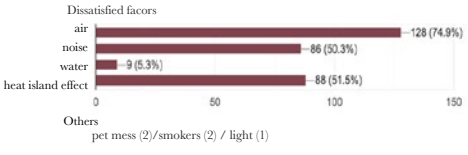


Built Environment

Pollution

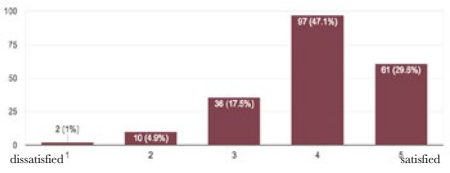
mostly dissatisfied (36.4%)
problems: air (74.9%); heat (51.5%); noise (50.3)

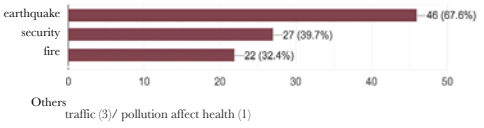




Safety

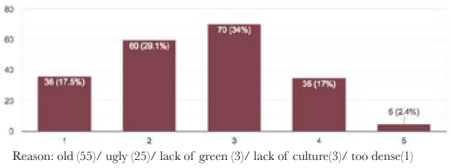
mostly satisfied (76.7%)
problems: earthquake (67.6%); security (39.7%); fire(32.4%)





Cityscape and architecture

mostly dissatisfied (46.6%): old and ugly

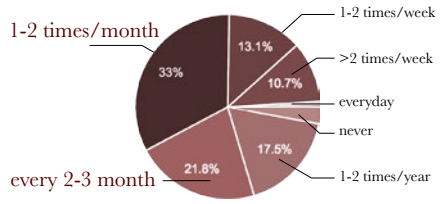


Others suggestions for the city

- Urban Renewal (10)
- Traffic disturbance (7)
- Lack of parkint lots (5)
- Bicycle lanes improvement (5)
- Lack of green (5)
- Accessible for disable people (3)
- Narrow lanes (3)
- Noise (2)
- Disordered buildings (2)
- Lack of public garbage can (2)
- Lack of athetic (1)
- Homeless (1)
- Disordered pipeline (1)
- Long-term care (1)

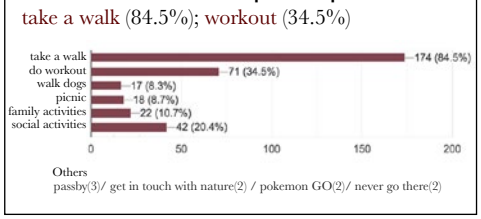
Urban Open Space

Frequency of visiting

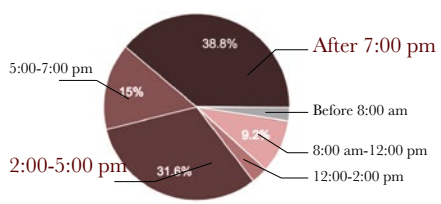


Activities in an open space

take a walk (84.5%); workout (34.5%)



Time of using an open space



Other seggestions

- More trees (too hot) (7)
- Lack of open space (7)
- Ill asthetic (5)
- Maintanence (5)
- More connected (2)
- More ecological (2)
- Accessibility (2)
- Public toilet (2)
- Lightening (1)

Other Literature Reviews

Safety Assessment

Security

The 3rd safest city in the world according to crime index.

(Numbeo, 2017)

Earthquake

The top 9 cities with the highest "city risk" in the world, due to the natural disasters and old buildings /infrastructures.

(The Financial Times of UK)

Fire

The disaster relief has become a problem during disasters due to narrow lanes.

(Taipei City garvernment, 2017)

Ecological unfriendly city:

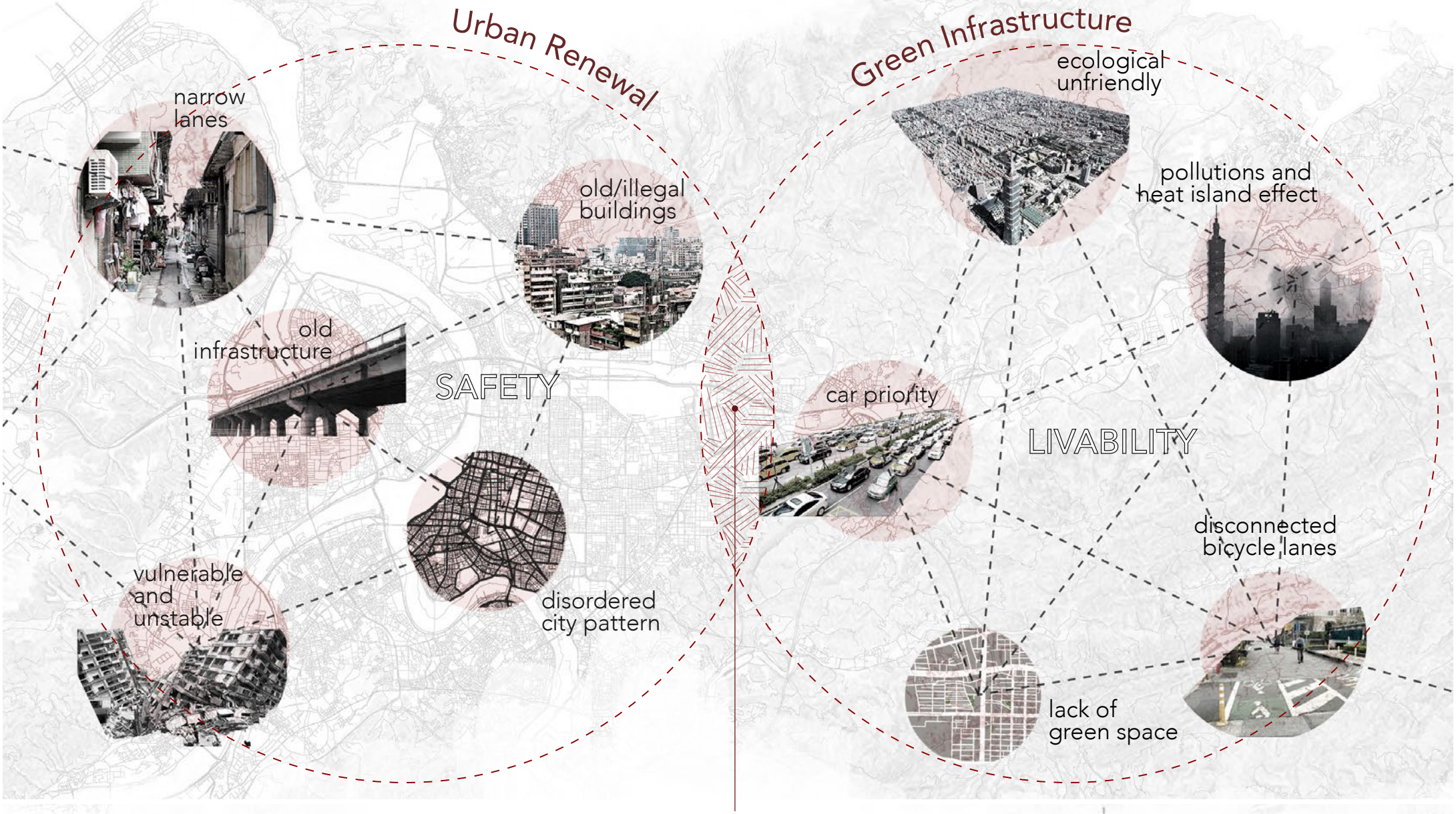
1. Insufficient and uneven distribution of park green space
2. Planning green space is occupied or used as other purposes
3. Lack of integrated plan of green infrastructure system
4. Failure to integrate with the urban blue-green connection
5. Over-design with too many man-made facilities

(Wang & Zeng, 2009)

STRATEGY

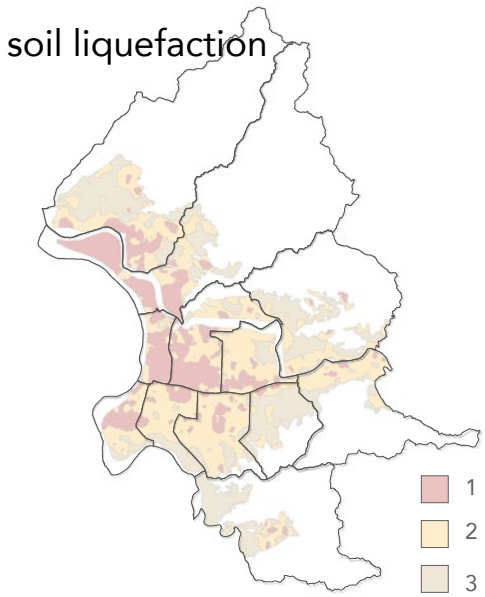
Combining the results of the survey and literature reviews, the negative spatial qualities in Taipei are organized as below, divided into 2 groups: safety and livability issues. The strategies to tackle each of them are mentioned as well.

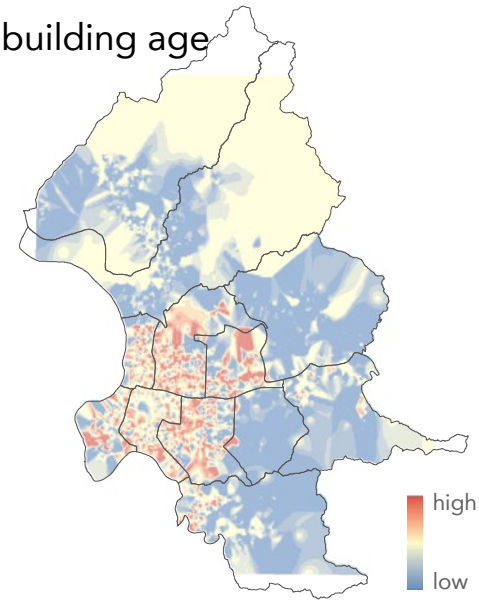
To deal with the problems of safety, the urban renewal is the key for the safety issues; on the other hand, green infrastructure can be adopted to improve livability.

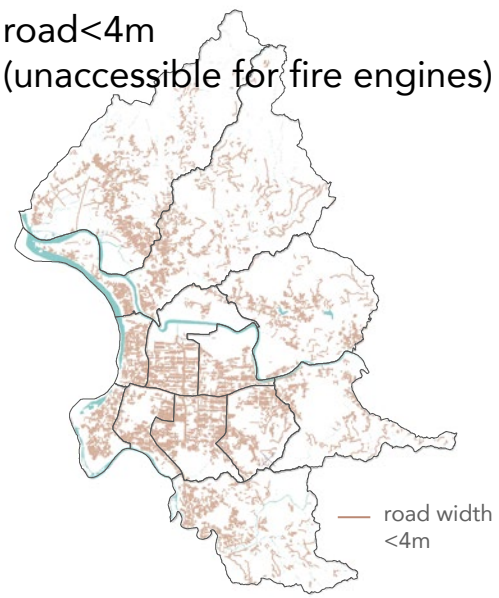


"Urban Renewal with Green Infrastructures"

URBAN RENEWAL PRIORITY ANALYSIS

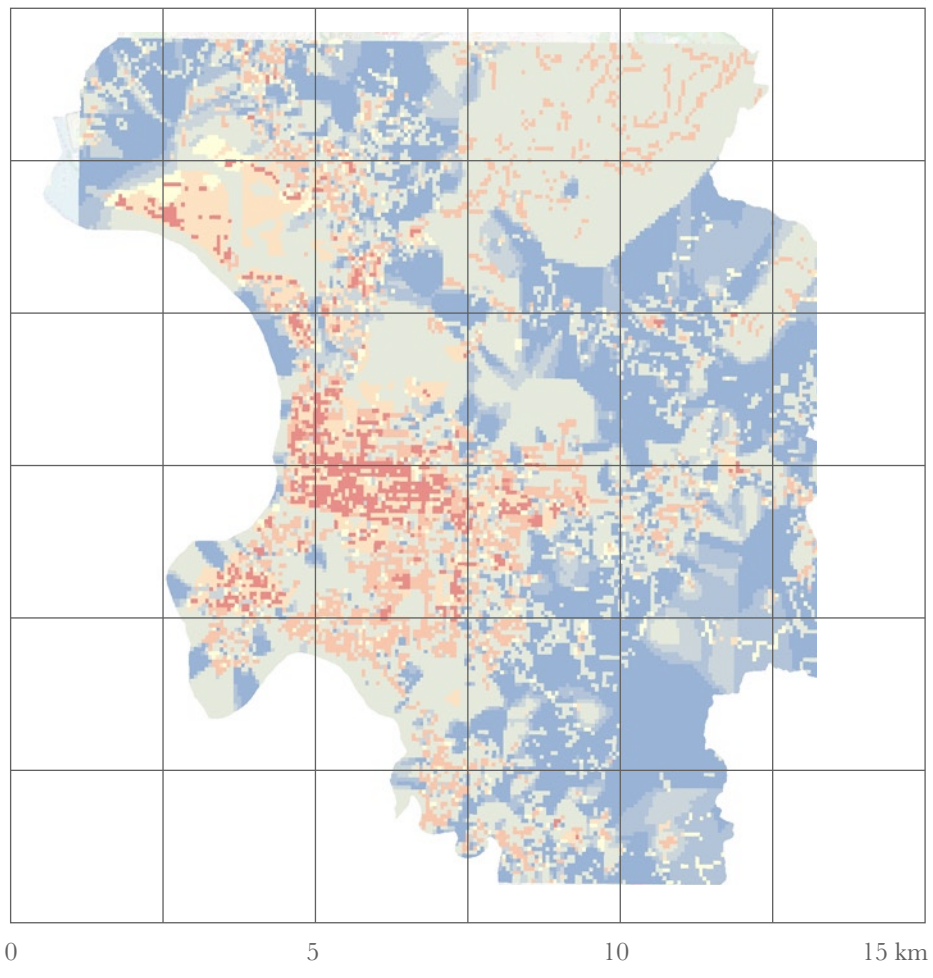


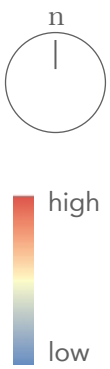




mapping

Renewal Priority Area





According to *Reconstruction of Old Buildings and Urban Dangerous Area Act (2017)*, in order to cope with the potential risks as well as accelerate the reconstructions of dangerous and old buildings, the corresponding area should be the priority to renew.

As a result, to find the renewal priority area, ArcGIS was used to map all the potential dangerous factors due to natural or man-made accidents in the city, which were soil liquefaction potential area, building age and narrow roads (<4m, inaccessible for fire engines).

The final result is shown as the diagram on the left.

GREEN INFRASTRUCTURE ANALYSIS

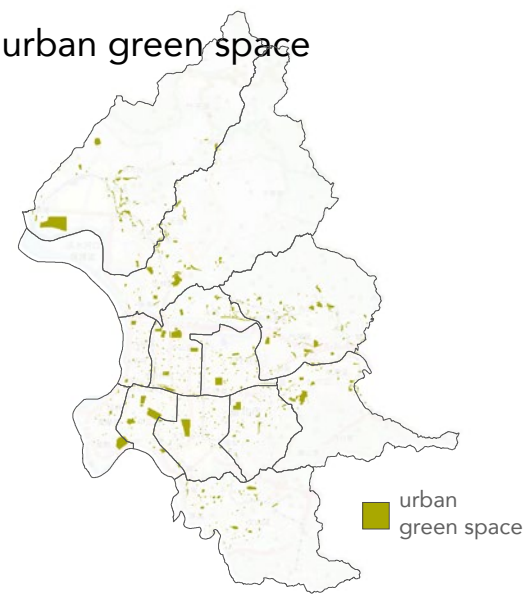
World Health Organization has suggested that a proper open space system for citizens should include the following conditions:

- Reachable within 15 minutes.
- At least 9m²/person

Instead, from the analysis of the current open space area and accessibility in Taipei City, it can be concluded that:

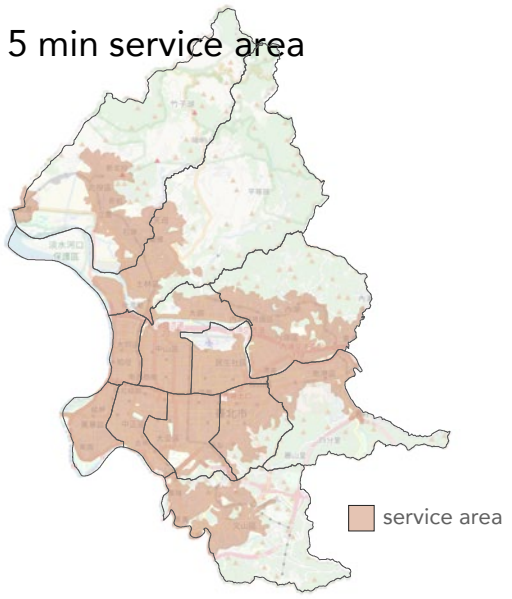
- Almost all the people can reach parks in 15 min
- Only 4.85m²/person

urban green space



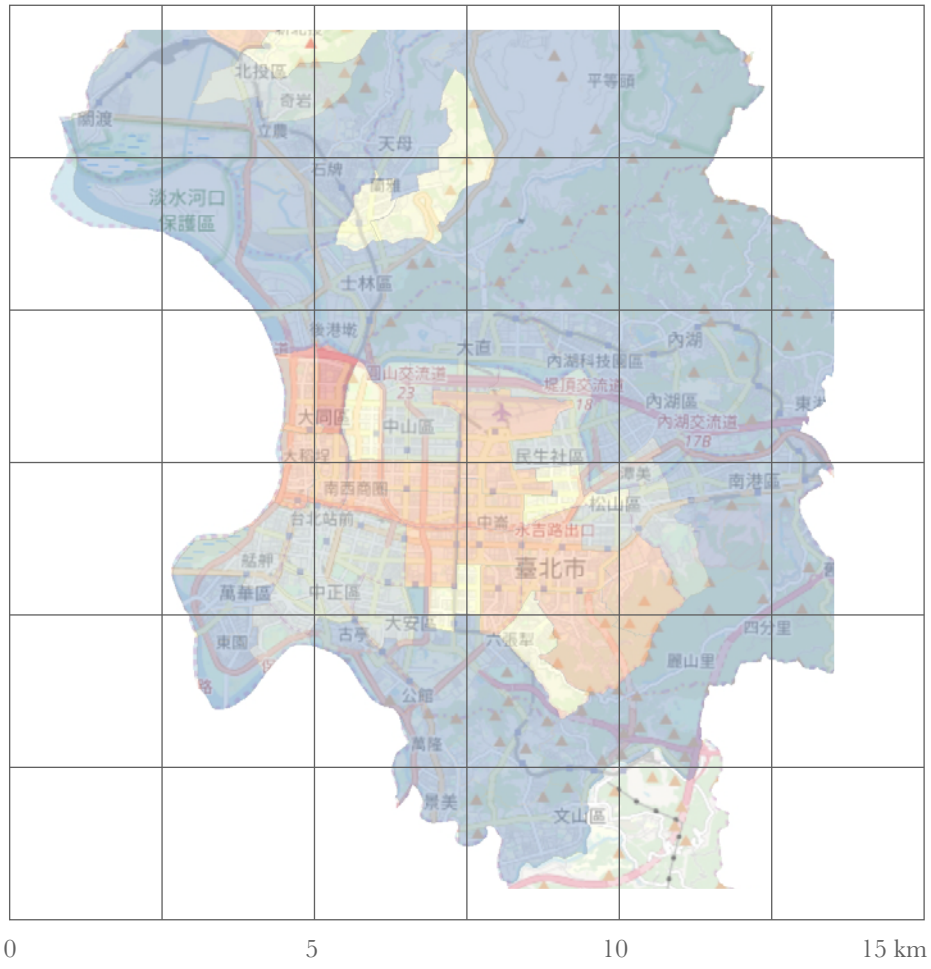
4.85m²/person

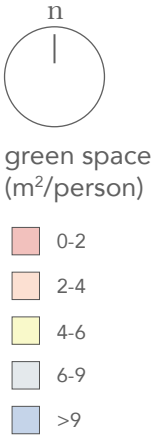
15 min service area



Reachable within 15 minutes

Proposed Green Area





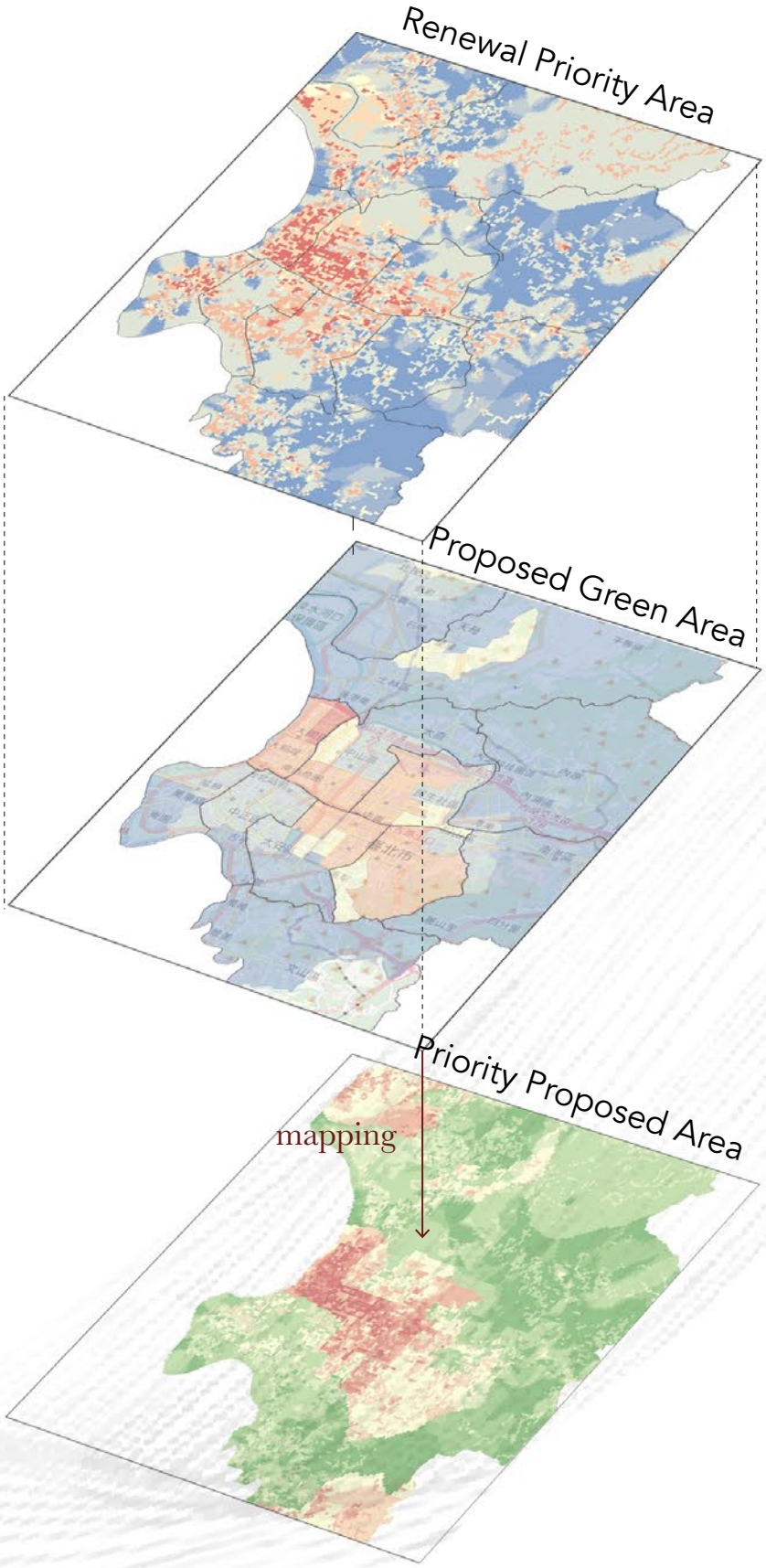
Therefore, the analysis above shows that the green infrastructure in the city is not enough.

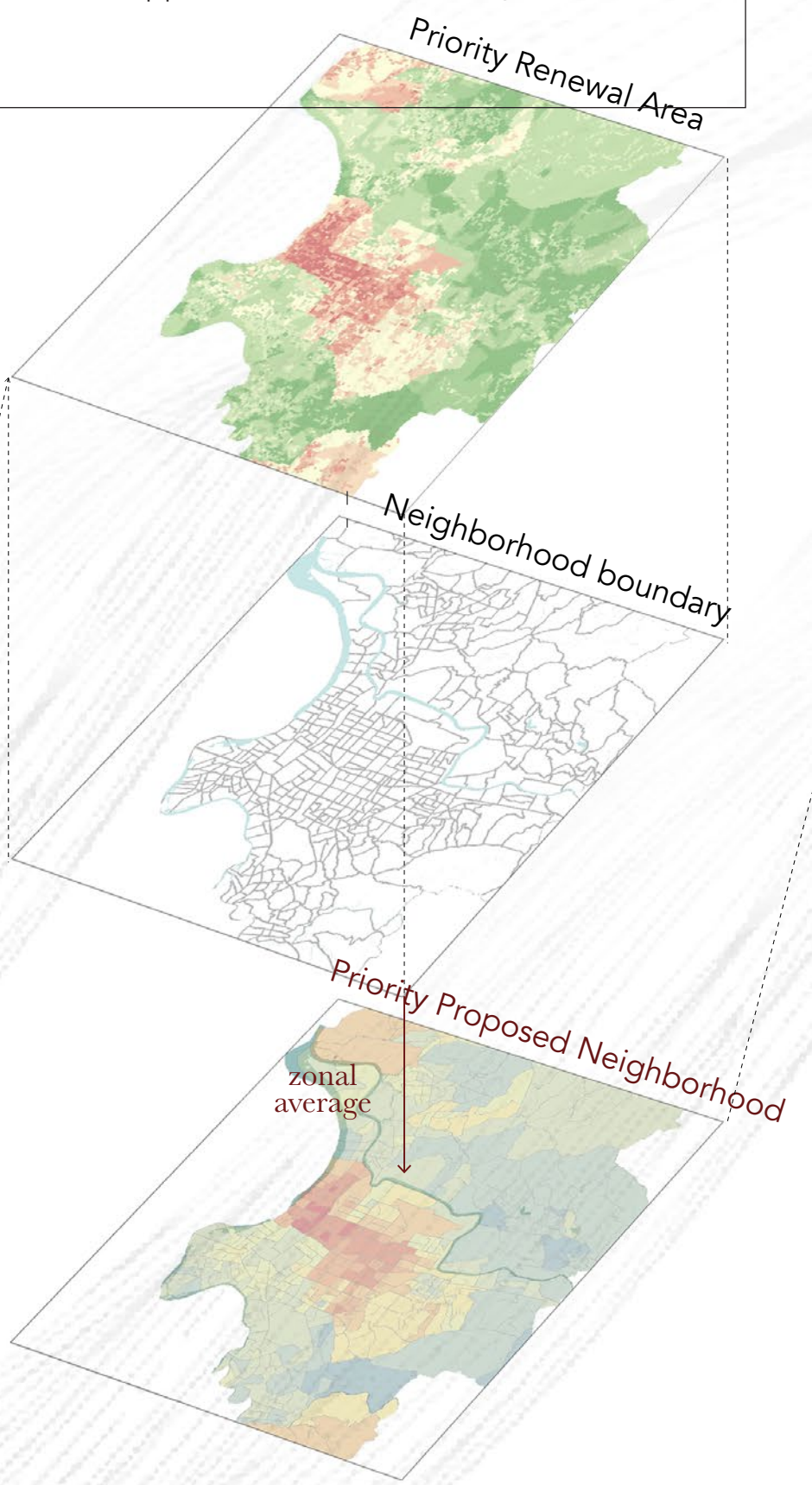
As the result, green space should be added where it is currently lacking. The diagram on the left shows in red, the area where the improvement of green space is a priority.

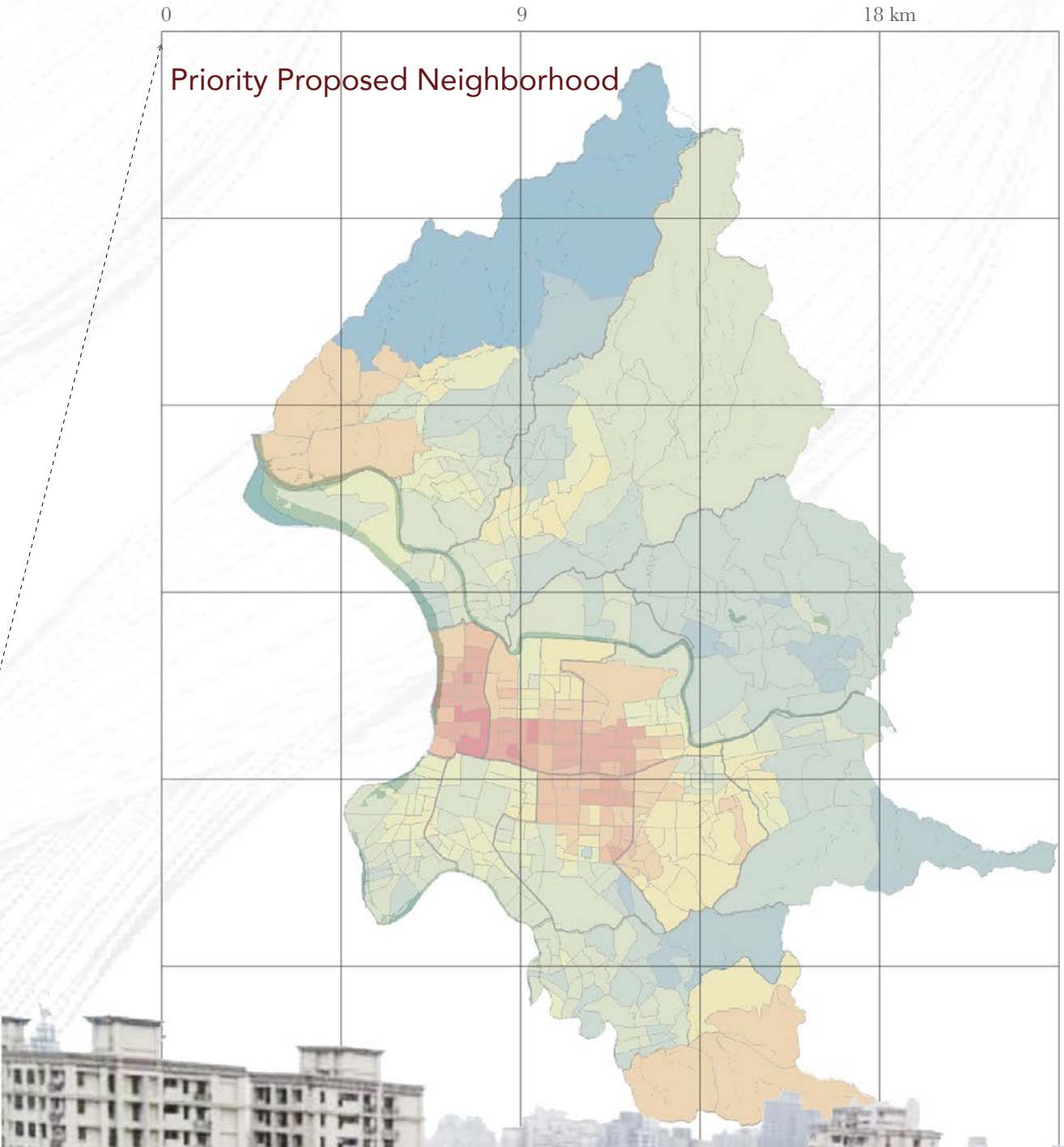
PROPOSED AREA

After the analyses of renewal priority area (unsafe area) and the proposed green area (lack of green area), ArcGIS was used to map them again to clarify the priority for the proposed area (unsafe and lack of green area).

Subsequently, since neighborhoods can be considered as units for renewal planning, the neighborhood boundaries are applied to the zonal average in ArcGIS.







Process :

Renewal Priority Area (unsafe area)

Proposed Green Area (lack of green area)

mapping

Priority Proposed Area (unsafe and lack of green)

Neighborhood boundary

zonal average

Priority Proposed Neighborhood

To sum up, the discussions in the next sections will focus on the priority neighborhoods, those with the values of more than 6 (colored from orange to red in the diagram on the left).

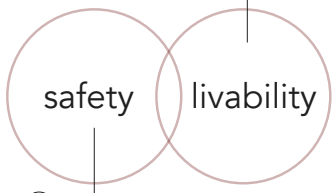
VISION

Taipei is a lively city with her own stories and cultures. Though renewal is an inevitable strategy of city developing, it is important to keep its culture in the city instead of removing all the contexts and creating a "Barbie City". As a result, the main goal of the vision is proposed:

"A safe and livable city without losing its context and culture."

To reach the vision, it is essential to throw back to the issues themselves. For the different issues, two approaches can be adapted.

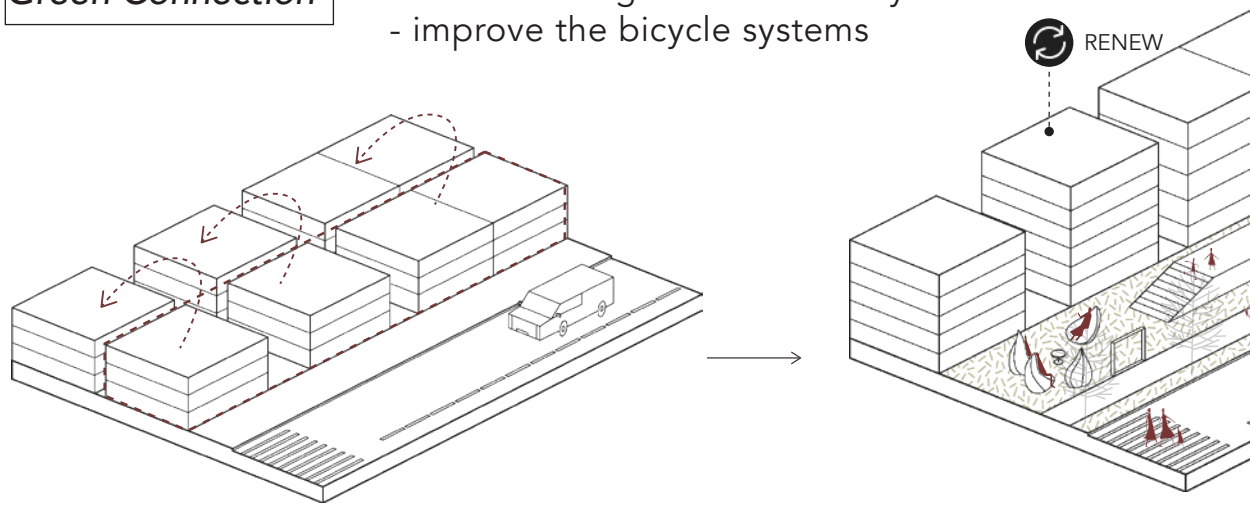
ecological unfriendly ①
pollutions and heat island effects ①②
car priority ①②
lack of green space ①②
disconnected bike lanes ①
social participation ②



narrow lanes ②
old buildings ①②
old structures ①②
disordered city pattern ①②
vulnerable and unstable ①②

Approach 1
Green Connection

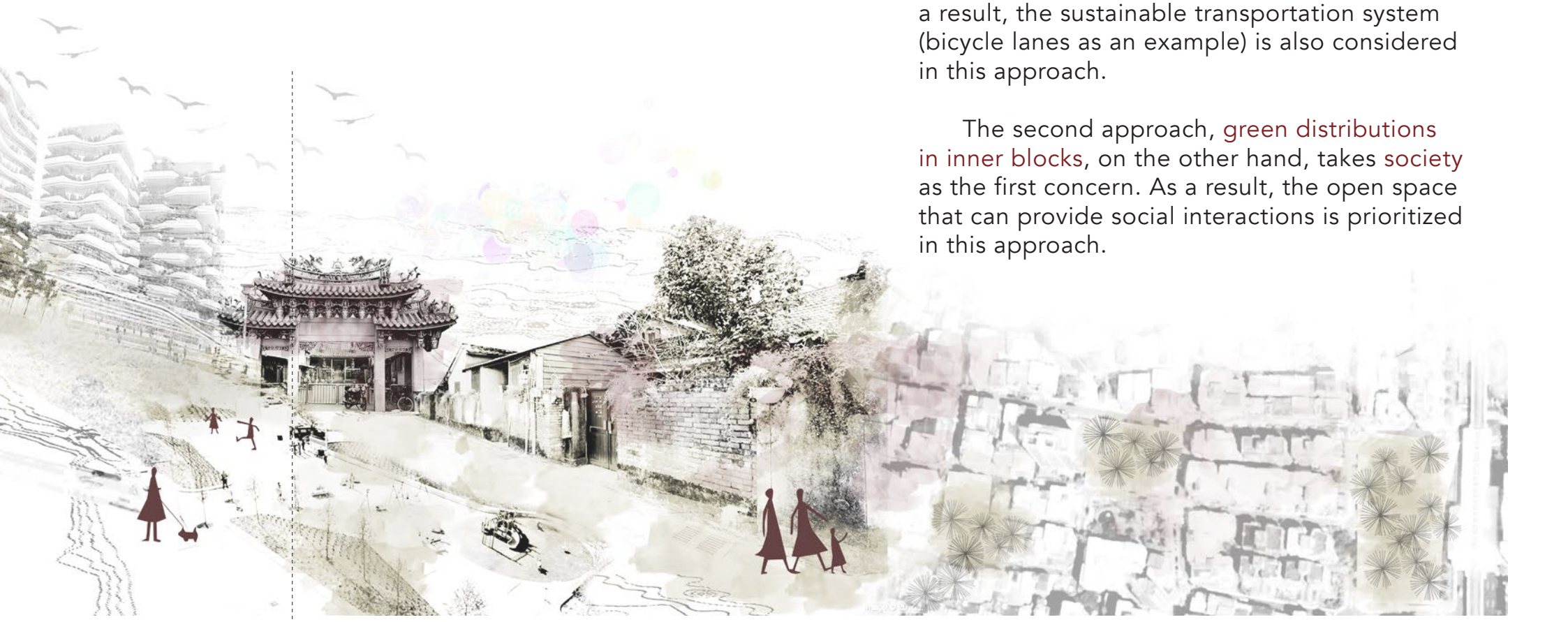
- renewal along the main roads
- widen the roads as linear green parks
- conncet the green and blue systems
- improve the bicycle systems

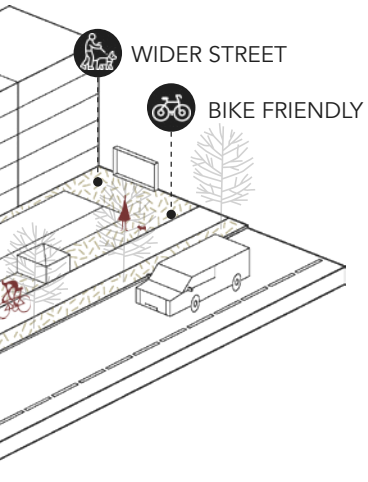


The vision can be divided into two parts with different approaches: along the main roads and inside inner blocks.

The first approach is green connections along the main roads. It is focused on improving the connections with green infrastructures. As a result, the sustainable transportation system (bicycle lanes as an example) is also considered in this approach.

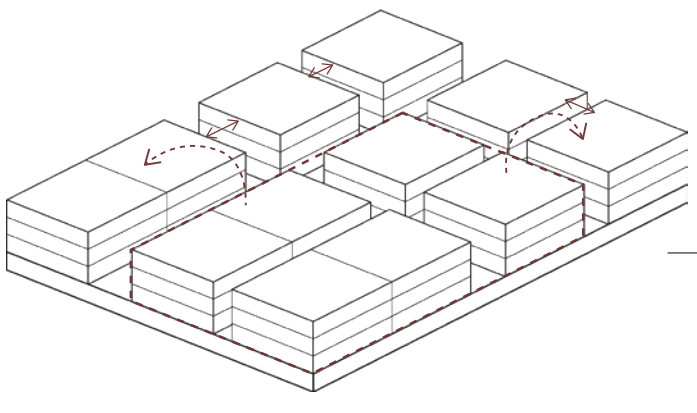
The second approach, green distributions in inner blocks, on the other hand, takes society as the first concern. As a result, the open space that can provide social interactions is prioritized in this approach.

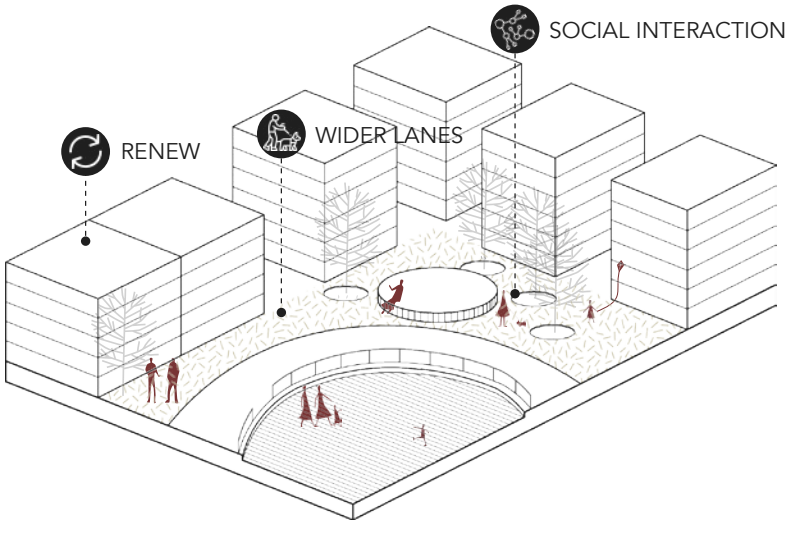




Approach 2
Green Distribution

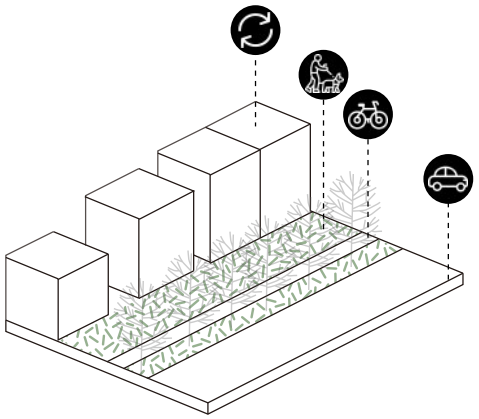
- renewal inside the blocks
- leave more open space for social interactions
- widen the lanes
- social participation





RESULT OF THE LAYER

Green Connection



Related Planning

1. Ecological connection:
Connect the green and blue system.
(Department of Urban Development, Taipei City Government, 2003)

2. Functional connection:
Connect to different districts and green systems with bicycle lanes.
(Council for Economic Planning And Development, 2008)
Current bicycle systems are meant to connect the metro stations.
(Department of Transportation, Taipei City Government, 2016)

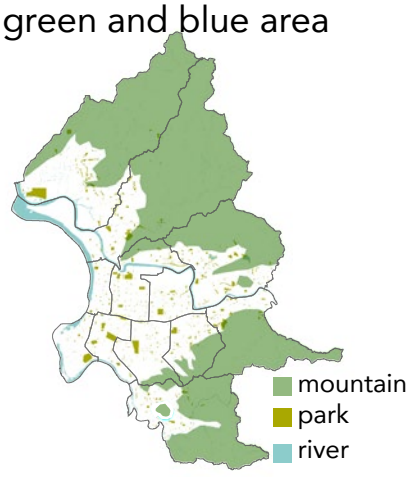
Current Conditions

poor cycle environment

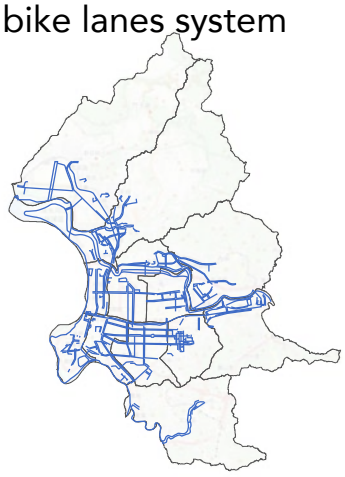
disconncection

Analysis

green and blue area



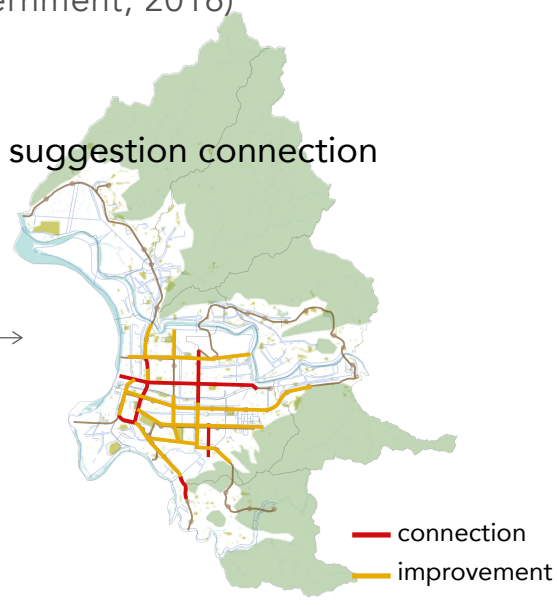
bike lanes system



main road and metro system

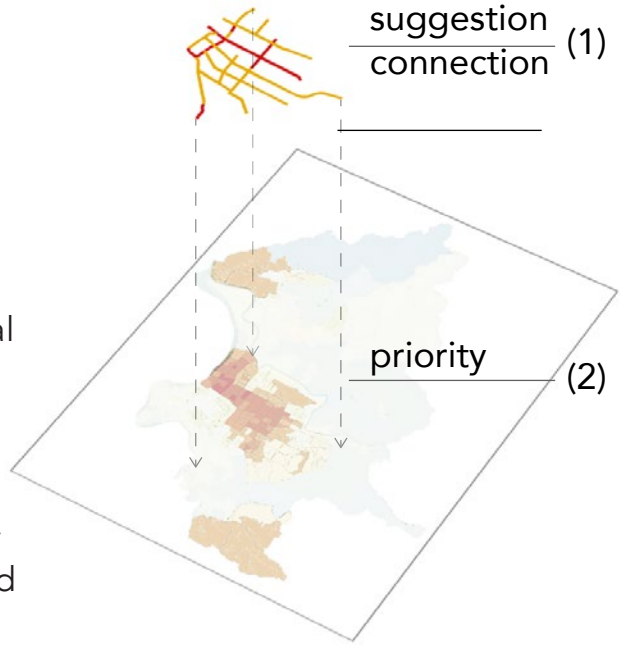
mapping

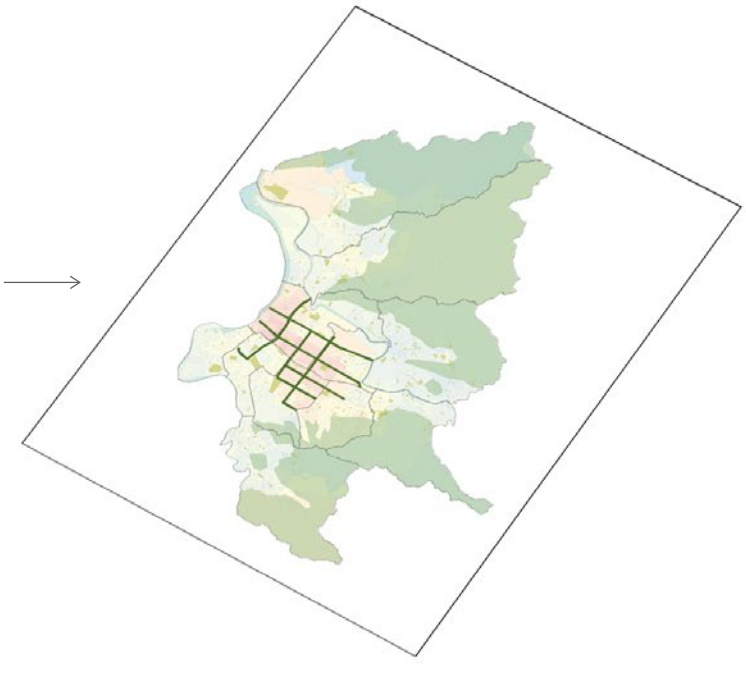
suggestion connection



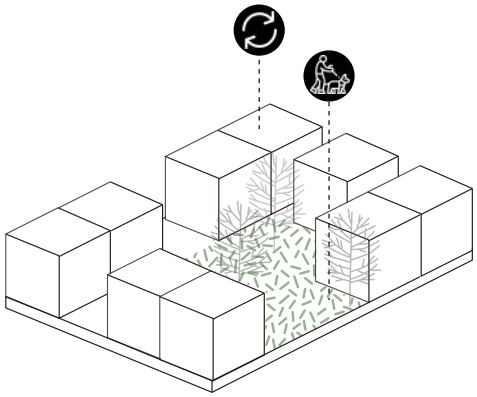
According to the analysis of the current connections, the suggestion diagram (1) has showed the proposed improvement and connection sections. Therefore, in order to explore the renewal priority, the suggestion map (1) and the priority proposed renewal map (2) are applied.

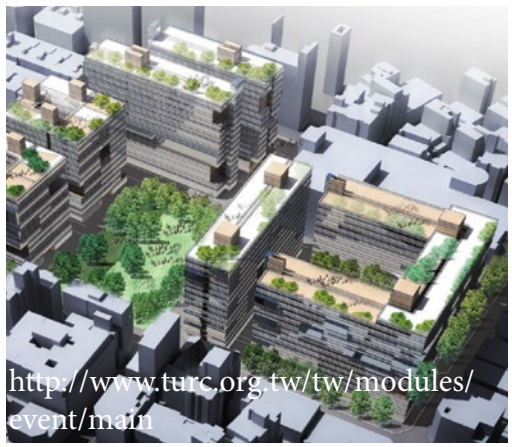
The final map applies the red line (connection) and the orange line (improvement) if they overlap with the priority proposed area.





Green Distribution





Key of Success

- Residents:
  - Considered the place attachment of people. (be able to move back afterward)
  - Promised a better living quality. (same amount of area in the house) (larger open space)

- Economical:
  - The spend can be fully covered by the process itself.

Local Pilot Project

Urban Renewal in Lanzhou-Siwen Area

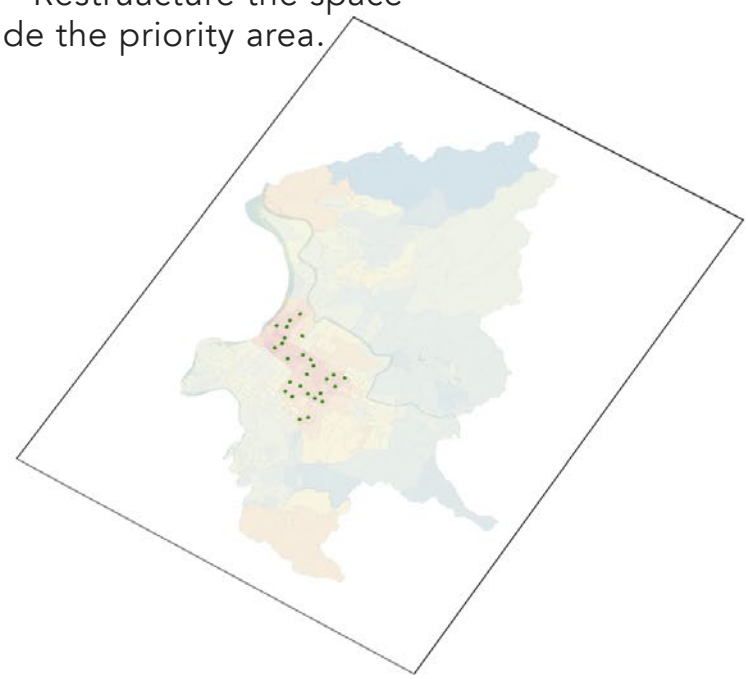
The first successful renewal project was done by the Taipei government. This project was agreed by 98% of the residents and the cost could be totally covered by the economic benefits itself.

The project is now on construction and all the residents had been moved to temporary houses. These houses were built on an old school site which was abandoned due to the low birth rate. After complete the construction, the residents will be able to move back and have the same amount of space as they had before.

After the construction, the living quality will be much better for the residents with new/safe buildings and larger green space. (Taipei Urban Regeneration Center, 2018)

Green Distribution

Restruacture the space inside the priority area.



05

- Combine layers
- Open space typology
- Design strategy

TYPOLOGY

A Safe and Livable City : Combine Emergency and Living Quality

In this chapter, the results from the emergency and living quality layers of chapter 3 and 4 will be combined, and the typology of the open space system for both emergency and living quality will be proposed.

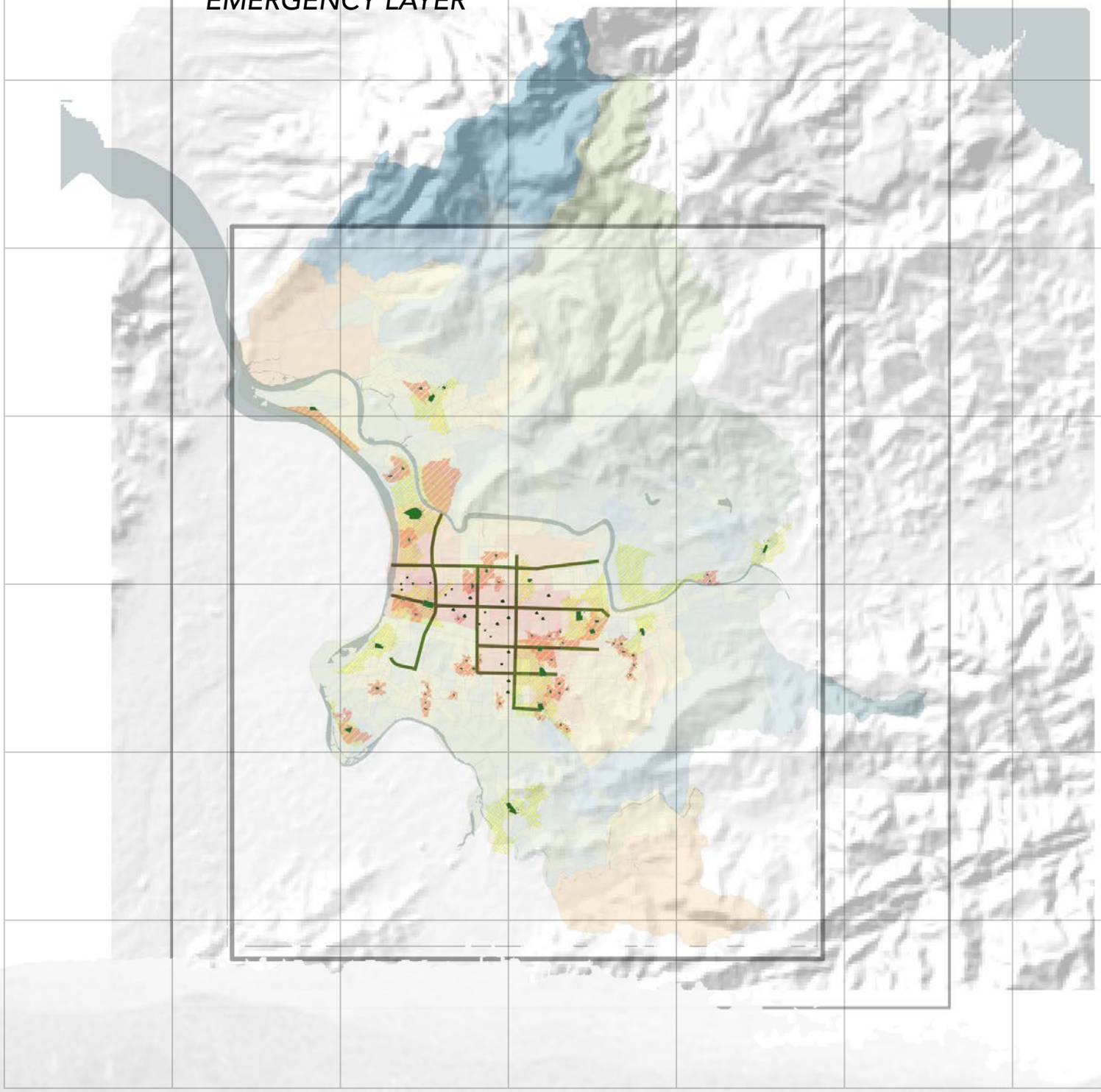
The emergency layer in chapter 3 concludes with the uncovered area of temporary gathering sites and evacuation sites, which are the unsafe area in the city while earthquakes happen.

On the other hand, in chapter 4, the areas where have a priority to improve the green connections and distributions were identified, based on living quality issues.

To propose the solutions of open space system in Taipei for both situations, the improved features of both layers are mapped as the diagram on the right.

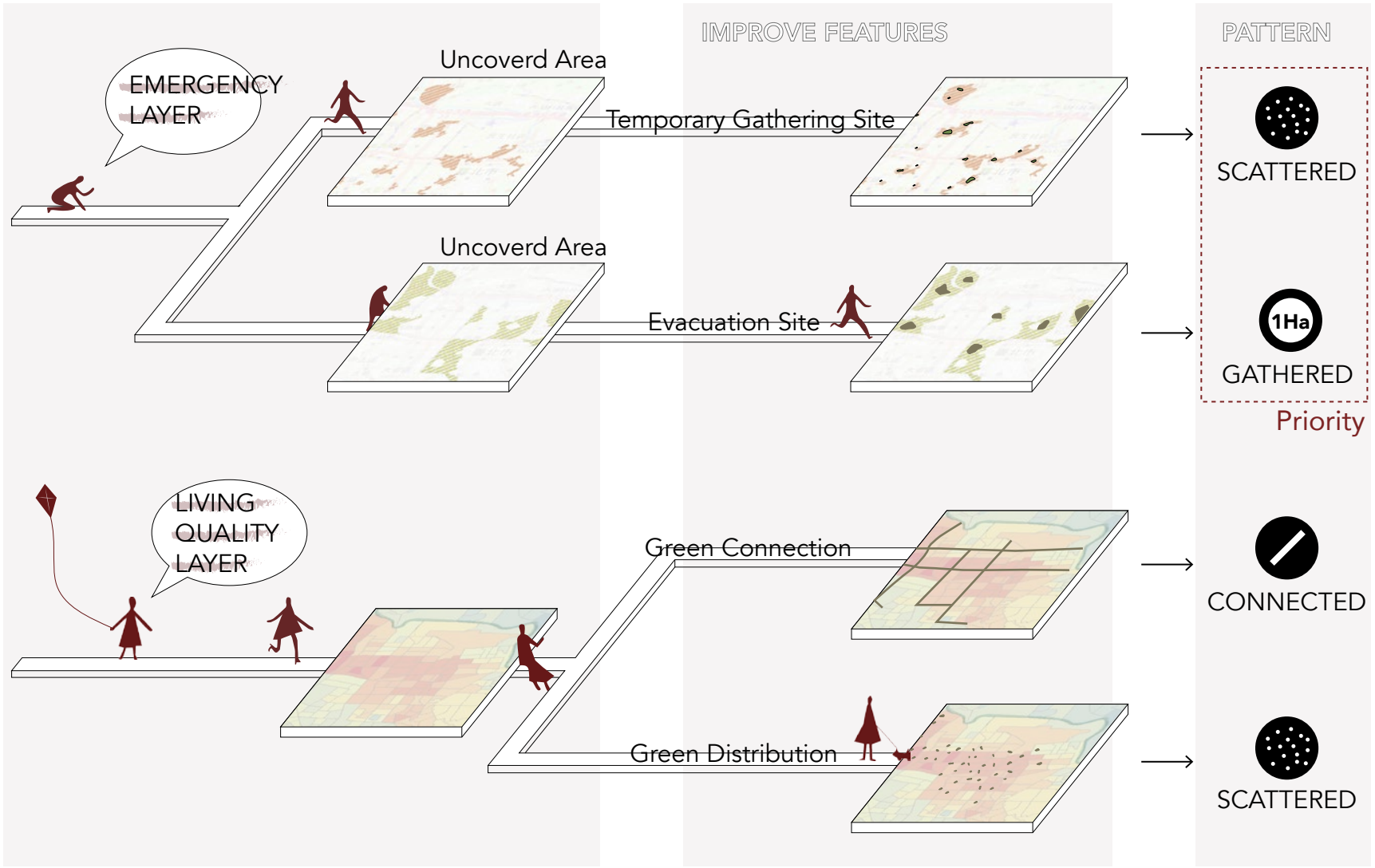
LIVING QUALITY LAYER

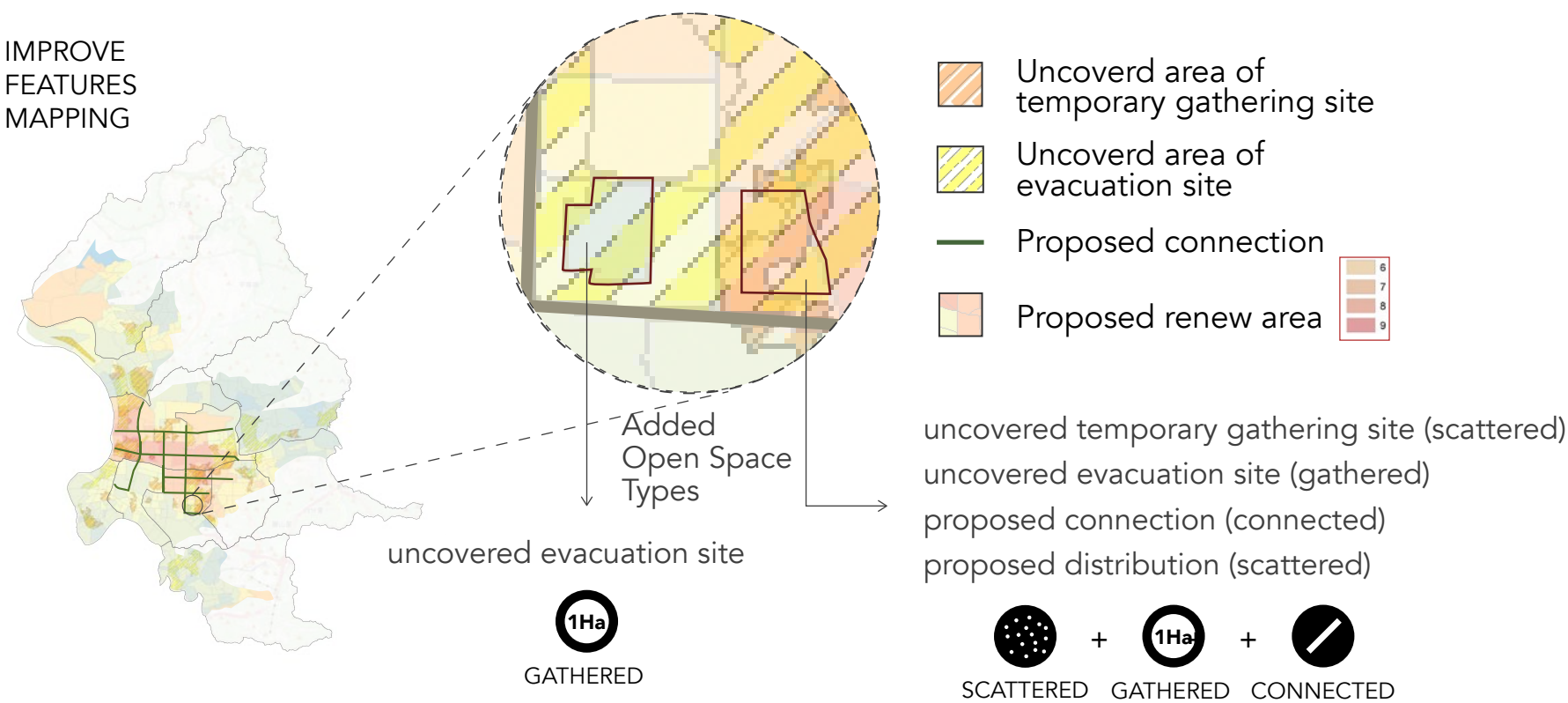
EMERGENCY LAYER



0 5 10 15 20 25 30 35km

OPEN SPACE TYPOLOGY





Apply on Site

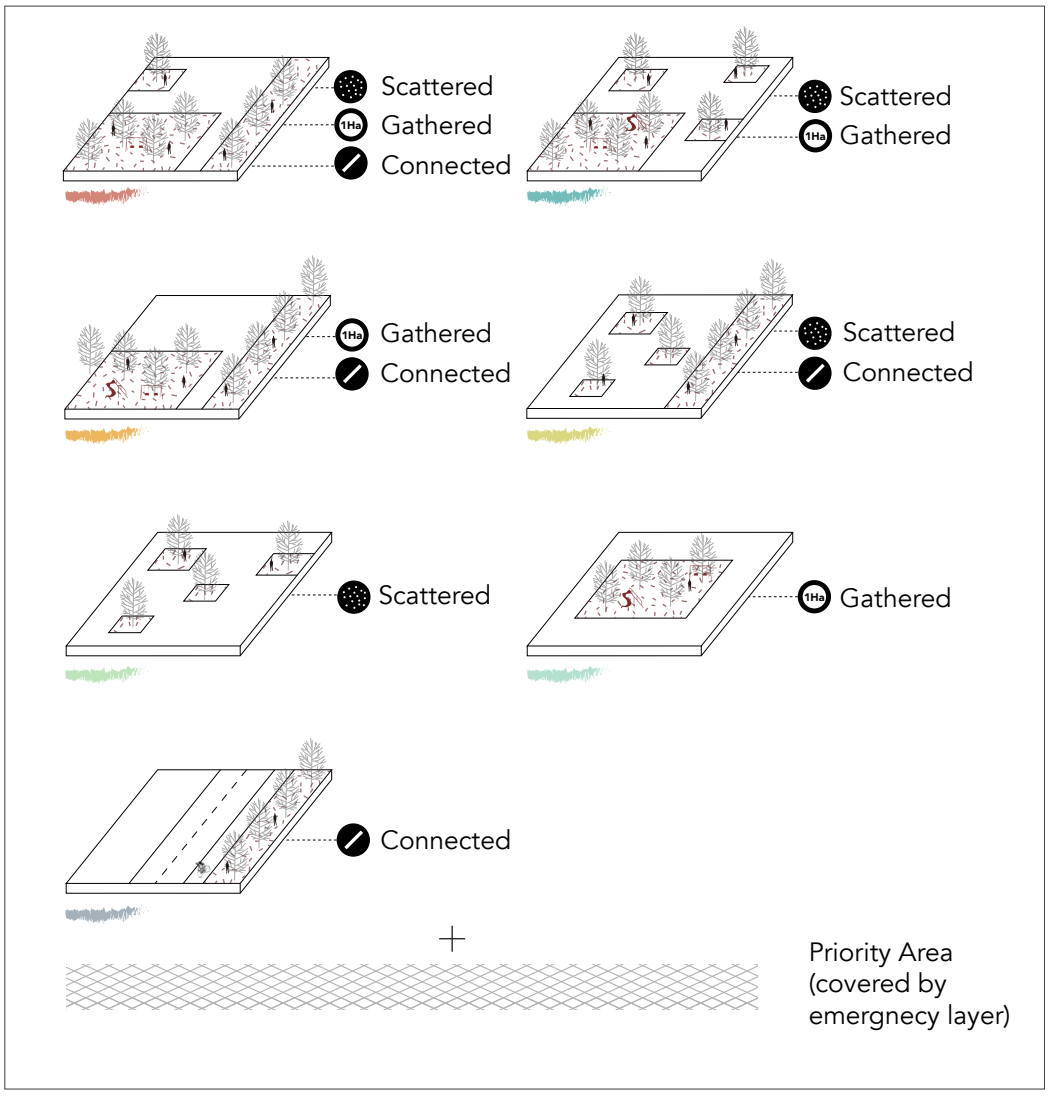
After combining two layers, the improved features are overlapped as the diagram on the left:

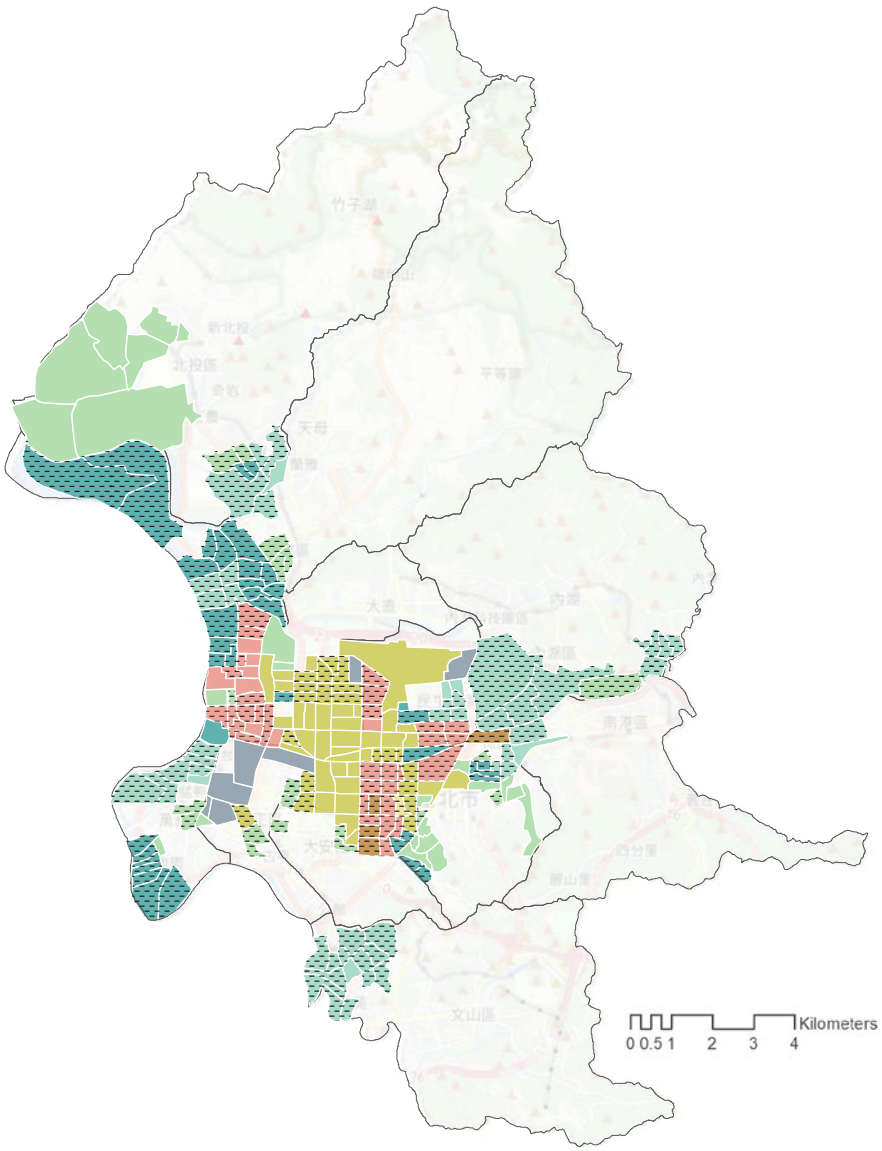
For the emergency layer, the uncovered areas, where are considered as unsafe area, should add more open space for evacuation. Besides, for different types of evacuation space, there are different requirements of the open space as mentioned before. That is, open space in the temporary gathering site can be small (scattered), while evacuation site should be at least 1 ha (gathered).

As for the living quality layer, green connection and green distribution are applied, which can be represented as connected and scattered patterns.

Categorize the Typology

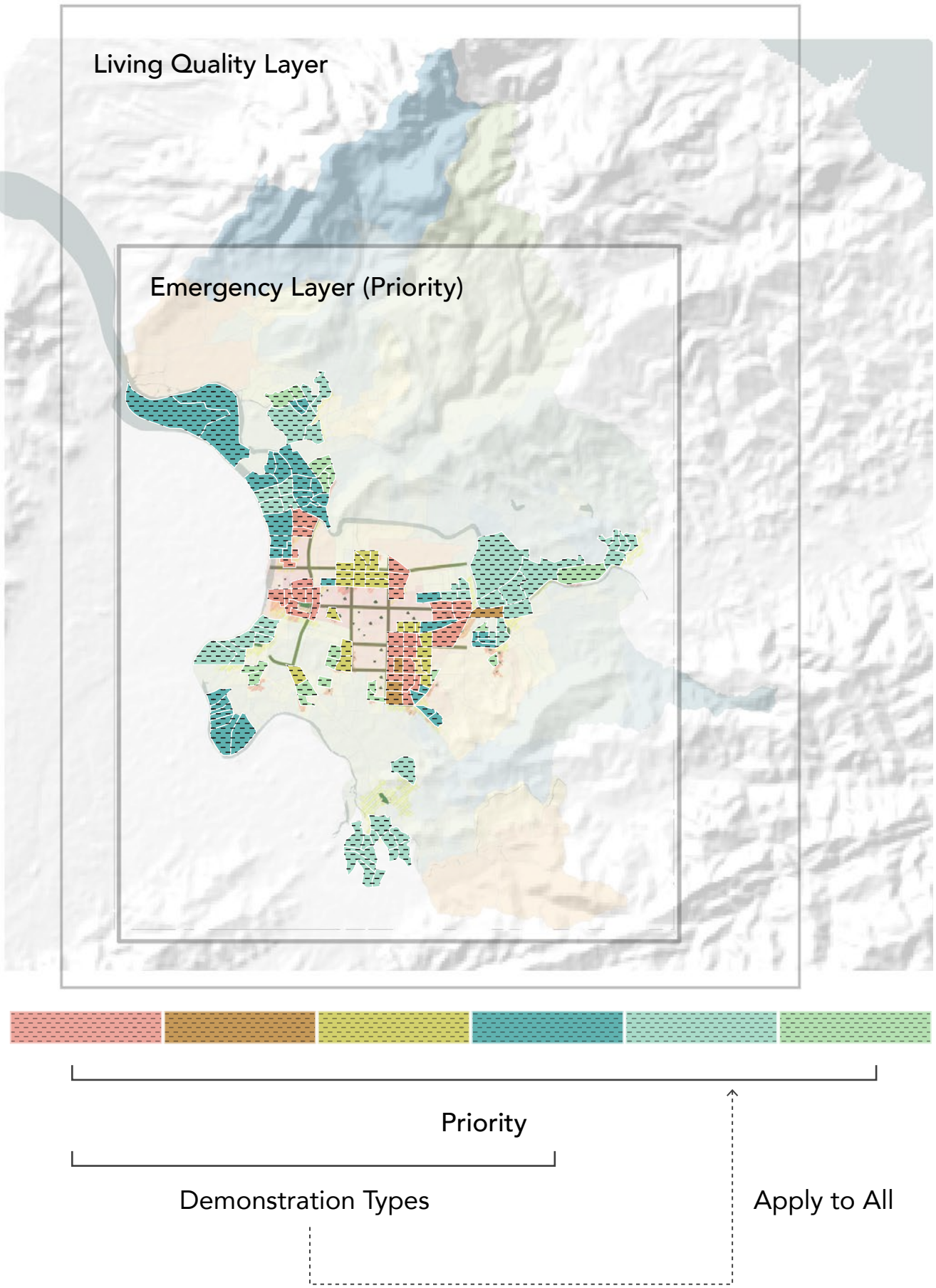
According to the descriptions, the areas can be categorized as seven different patterns. Moreover, the priority areas are those covered by the emergency layer (the areas with hatches on the map below).





Design Site

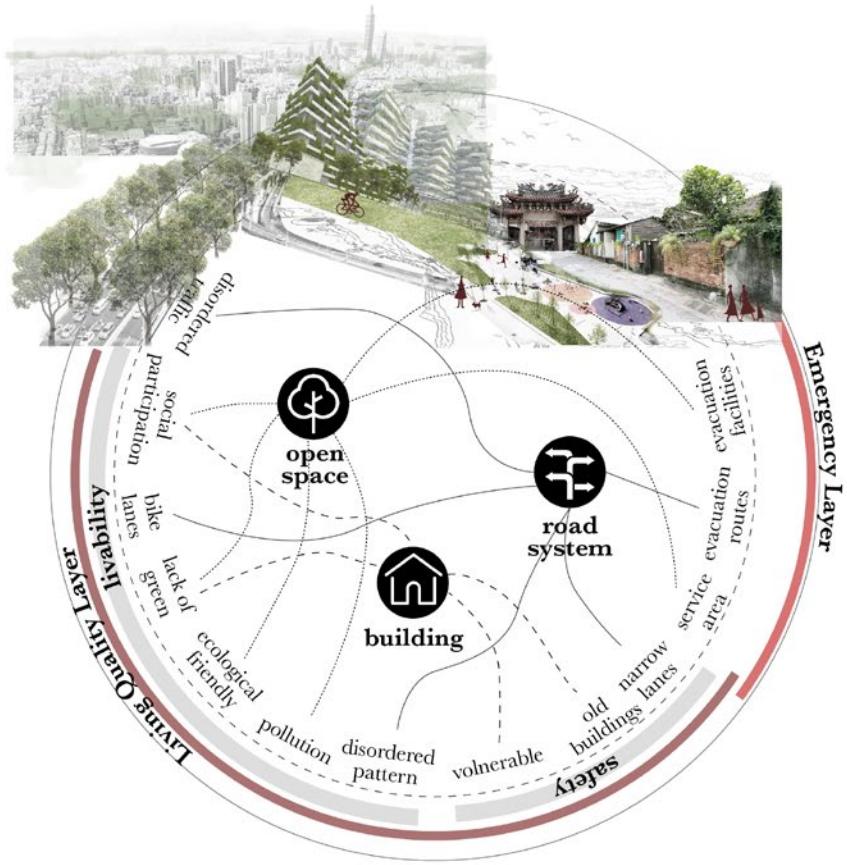
To zoom in to the detail design, two types of open space in priority areas are chosen: type1 (scattered+gathered+connected) and type2 (scattered+gathered).

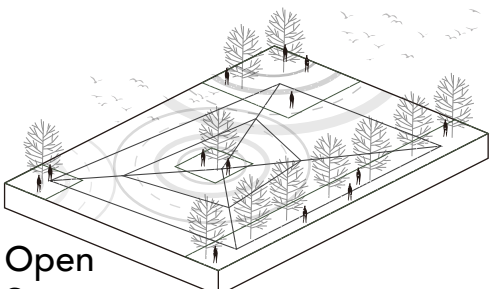


Design Elements

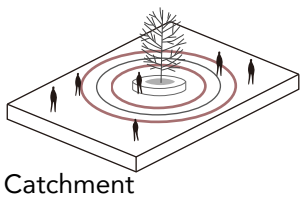
The design is based on two situations: emergency and daily life. Therefore, the required spatial conditions that were mentioned in the last chapters are showed on the right. These conditions are related to the spatial elements: open space, road systems, and buildings.

As a result, by listing all the requirements, the spatial design that can be considered as guidelines for the design elements are showed below.

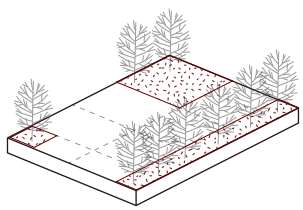




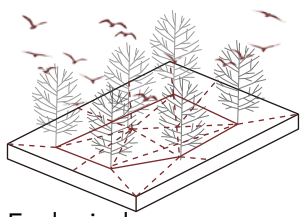
Open Space



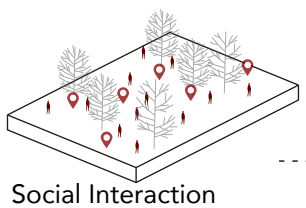
Catchment Area



Type



Ecological Friendly

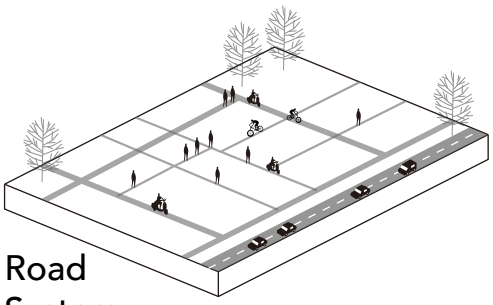


Social Interaction Hot Spots

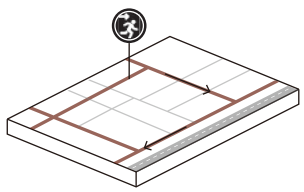
Analysis

current open space

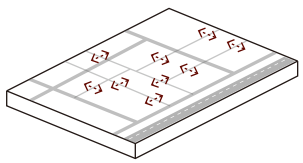
social analysis



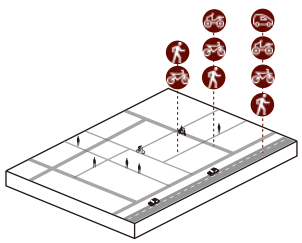
Road System



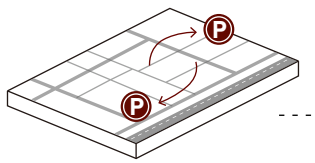
No Restriction Factors



Wider Streets



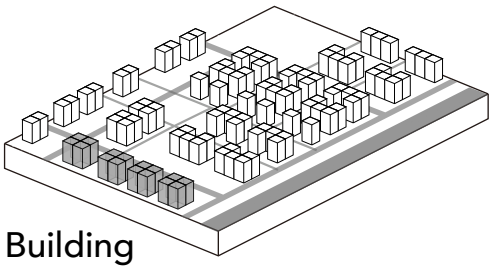
Car-free Systems



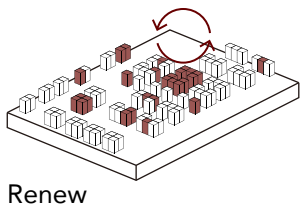
Reconsider Parking Space

street accessibility (1)

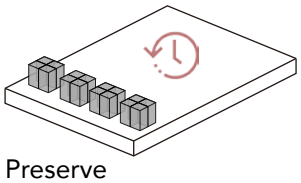
circulation



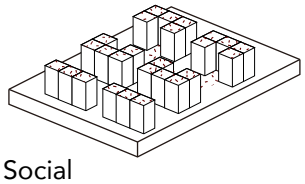
Building



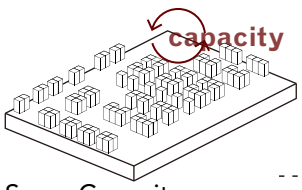
Renew Old Buildings



Preserve Historical Buildings



Social Space



Same Capacity for Current Residents

building quality (2)

building function

historical value

building capacity (3)

Assessment Reference

(1)
unsafe <4m
safe >4m (width)

The width required for firefighting is more than 4.1 meters.
(Taiwanese Government, 2013)

(2)
good <30 yrs
improvable 30-40yrs
bad >40yrs

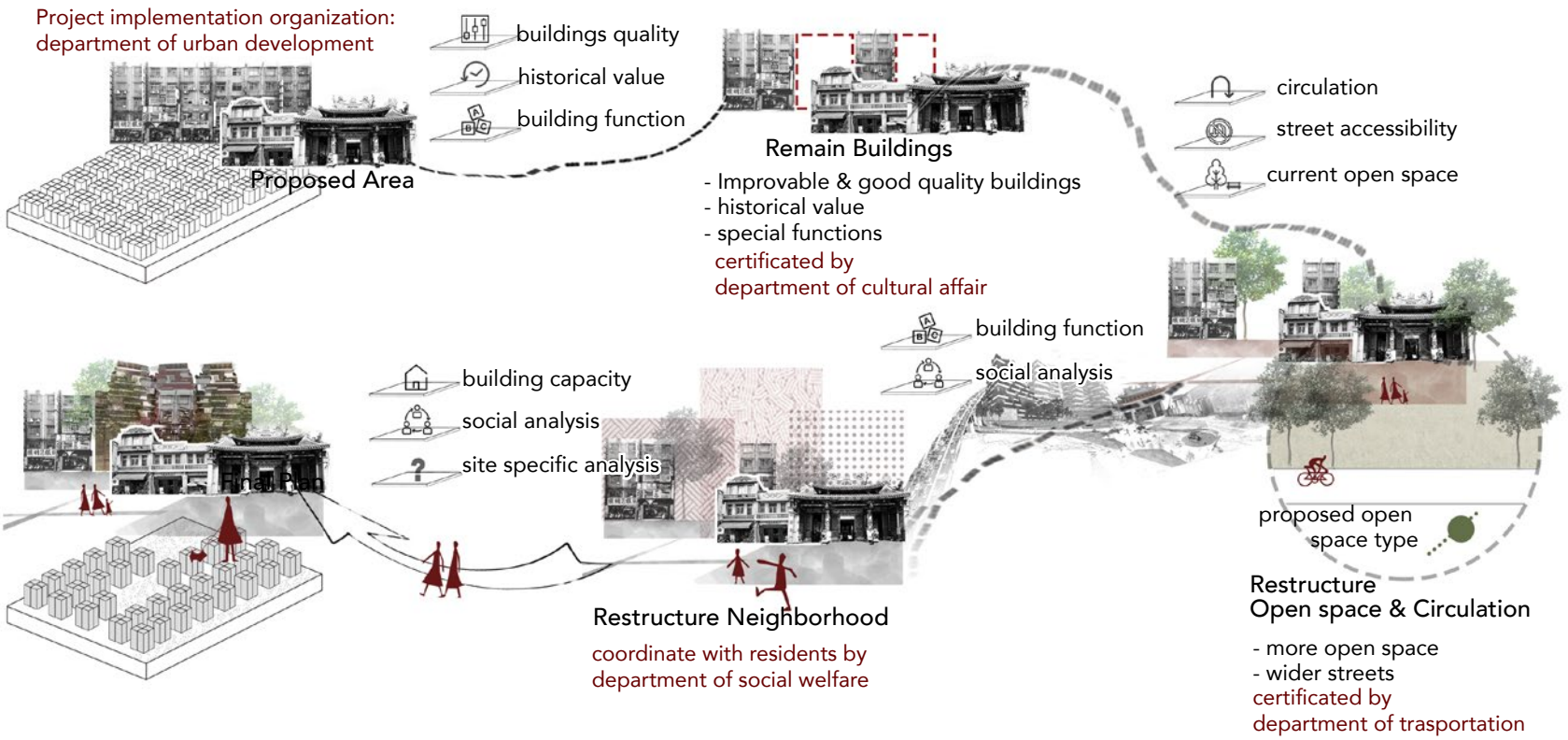
(3)
After renewal should be at least the same volume as before.

More than 30yrs can be assessed if the buildings are nessassary to be kept,
More than 40yrs can be removed
(Taiwanese Government, 2016)

Design Strategy and Related Organizations

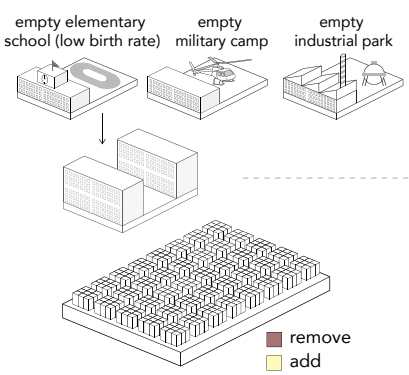
The design strategy is based on adopting the design elements and considering the analyses to reach the final proposal. The whole design will be taken in charge by the department of urban development, while in each aspect of the design there is a government department responsible for it.

- To remove the old buildings, the building quality analyses can serve as references. Also, to preserve the cultures, historical values and building functions analyses are applied (certificated by the department of the cultural affair).
- In order to reconstructure the open space and circulations, the lanes widths, the circulations, street accessibility, and open space analyses are adopted (certificated by the department of transportation).
- To restructure the whole neighborhood and preserve the context /social inside the neighborhoods, the analyses of the original functions and social activities in the area are essential (coordinate with residents by the department of social welfare).
- The detailing process, which combines the social analyses and other specific analyses on sites, to form the whole areas. Also, by analyzing the building capacity, can ensure the renewed areas will be enough for all of the residents to move back.



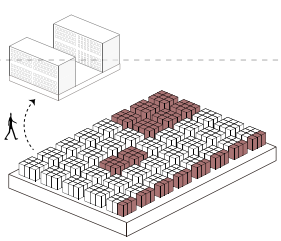
Design Process

Phase 0
temporary houses



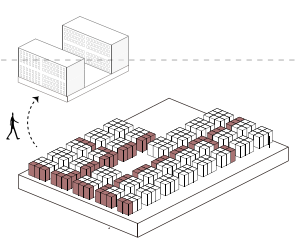
Phase 1
open space

type
service area
ecological friendly
social interaction



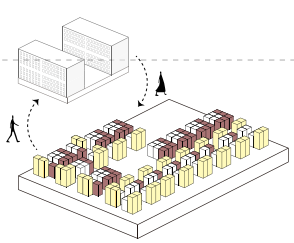
Phase 2
main street system

wider emgency routes
remove restriction factors



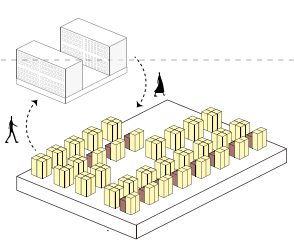
Phase 3
minor street system

wider streets
complete car-free system
reconsider parking space



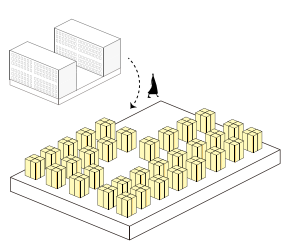
Phase 4
other old buildings

history preservation
create social space

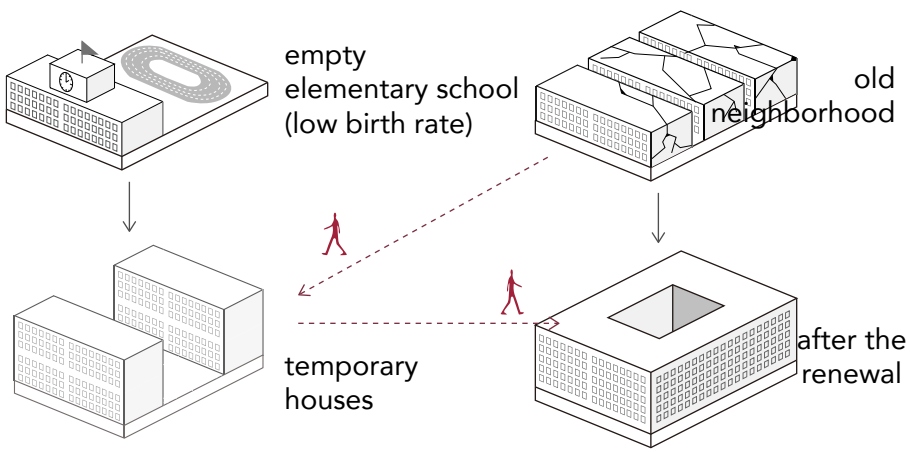


Phase 5
complete the renewal

same capacity after renewal



Investment Model of Renewal



The strategy of renewing the neighborhood is referred to as the latest and most successful renewal project in Taiwan, Lanzhou-Siwen renewal, which turned out more than 97% of the residents agreed on the plan. The project started in 2017 and is still on construction. Except for the benefits mentioned in the last chapters, there were two key strategies: cycle of buildings and economic benefits.

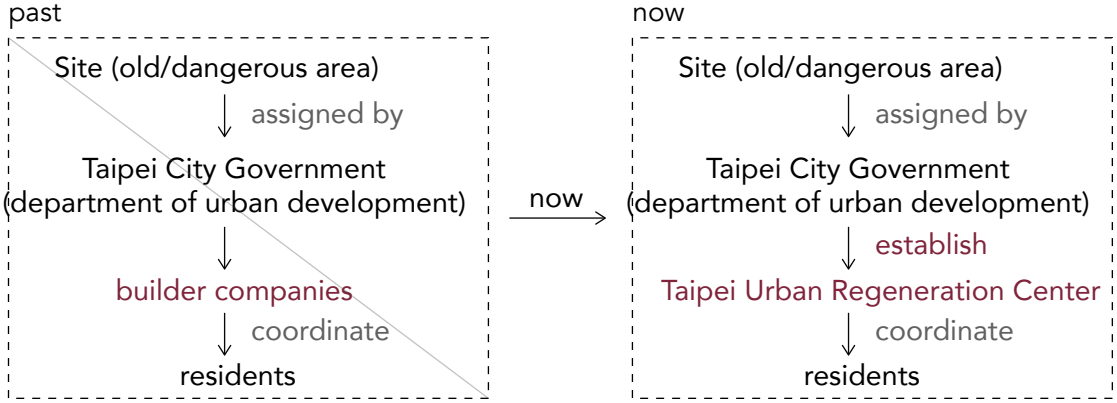
Cycle of Buildings

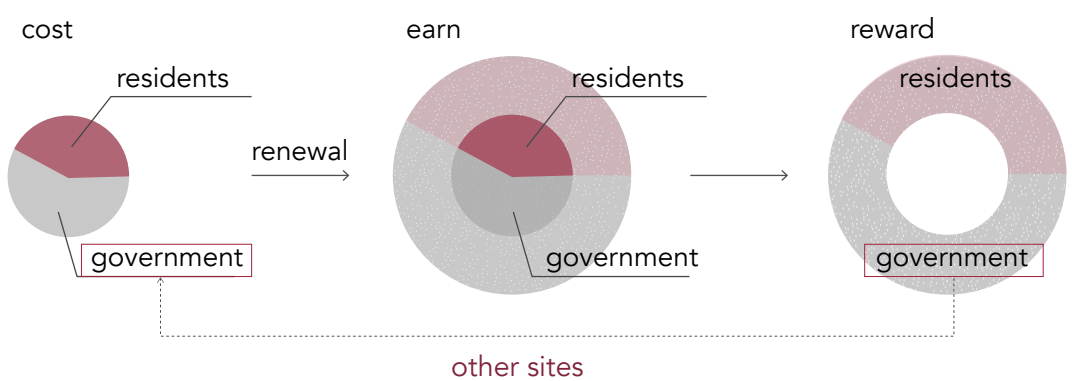
This strategy was successful because the government provided the residents with temporary houses, which were rebuilt from empty elementary schools nearby, abbandoned due to the low birth rate. This allowed the residents to move back and own the same amount of space after the renewal.

Economic Benefits

Since it was a "government-led renewal project", it efficiently avoided speculations from builder companies and focused on the city's benefits. The change of the process is shown as the diagram on the right.

Moreover, both residents and governments can get rewards from the renewal, which allow the government renewing other sites with these rewards.





06

- Design Principles
- Design Strategy
- Investment Model for Renewal
- Renewal Process
- Neighborhood Scale
- Detail Spatial Design

DESIGN INTERVENTION

The design intervention chapter will firstly apply the principles, that were mentioned in the last chapter, to the sites on the neighborhood scale. Afterward, the focus will zoom in again for detailing of the open space, which has an important role for both better living quality and emergency.

NEIGHBORHOOD SCALE

Type 1 Demonstration

Site Fascination

The site visit started from the area of the historical building, which still remains the facade from the Japanese colony. While moved on and turned to other blocks, the old and illegal buildings with narrow lanes appeared.

The other interesting experience was the leisure life here, people gathered together in the small temples inside the neighborhood. Also, there was a community park, which was not so fascinating.

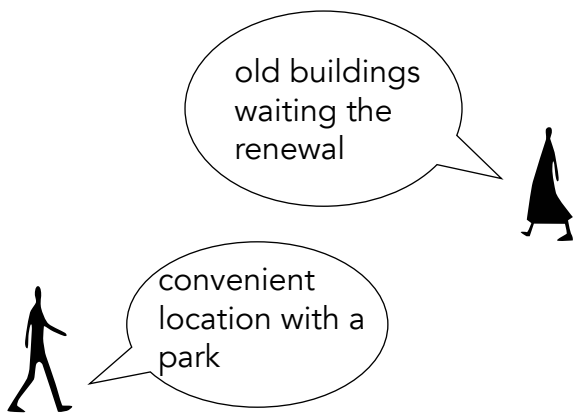
Historical Facade

Old Buildings

Narrow Lanes

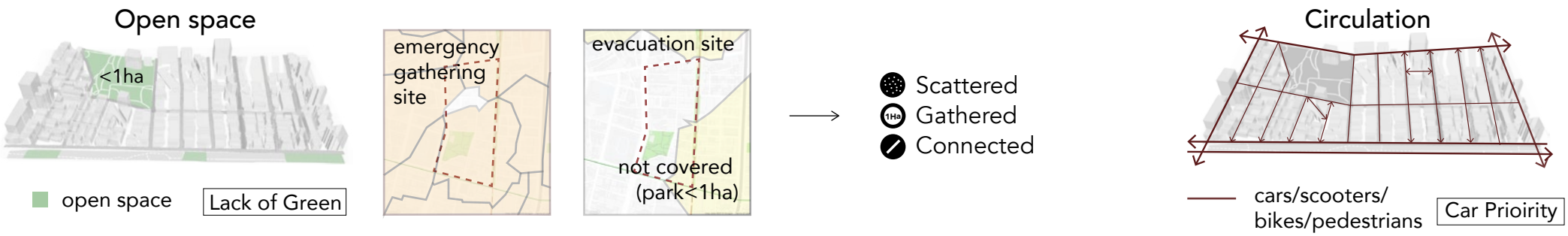
Temple

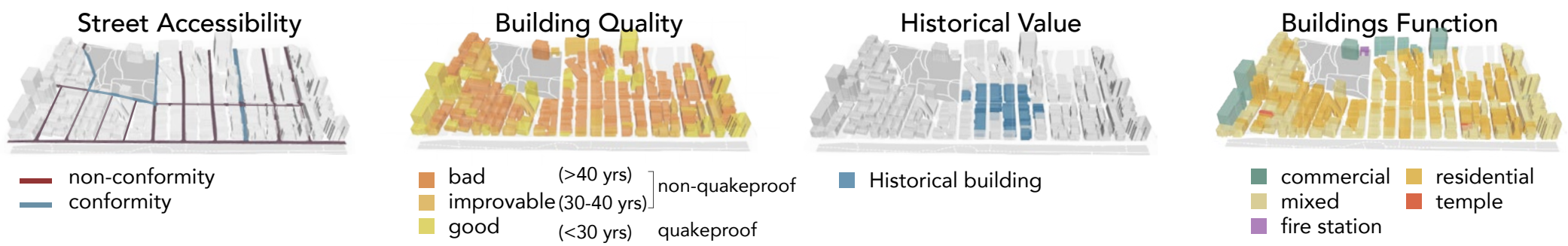
Community Park



Site Analysis

In the type 1 area, the improvement prototype of the open space is scattered, gathered and connected. Moreover, from the evacuation space point of view, there is lack of evacuation site due to the ArcGIS calculations. The other analyses according to the design principles are as following:





Temporary houses during the renewal

The illustrations on the right show how the number of elementary school students has dropped during the past decades as the low birth rate. On top of this, the maps also show the service area of the elementary schools, which are highly overlapped.

From the illustrations, one of the elementary schools can be transformed into temporary houses, since it will not influence any uncovered school service area. Also, the schools surrounded are enough for the number of current students.

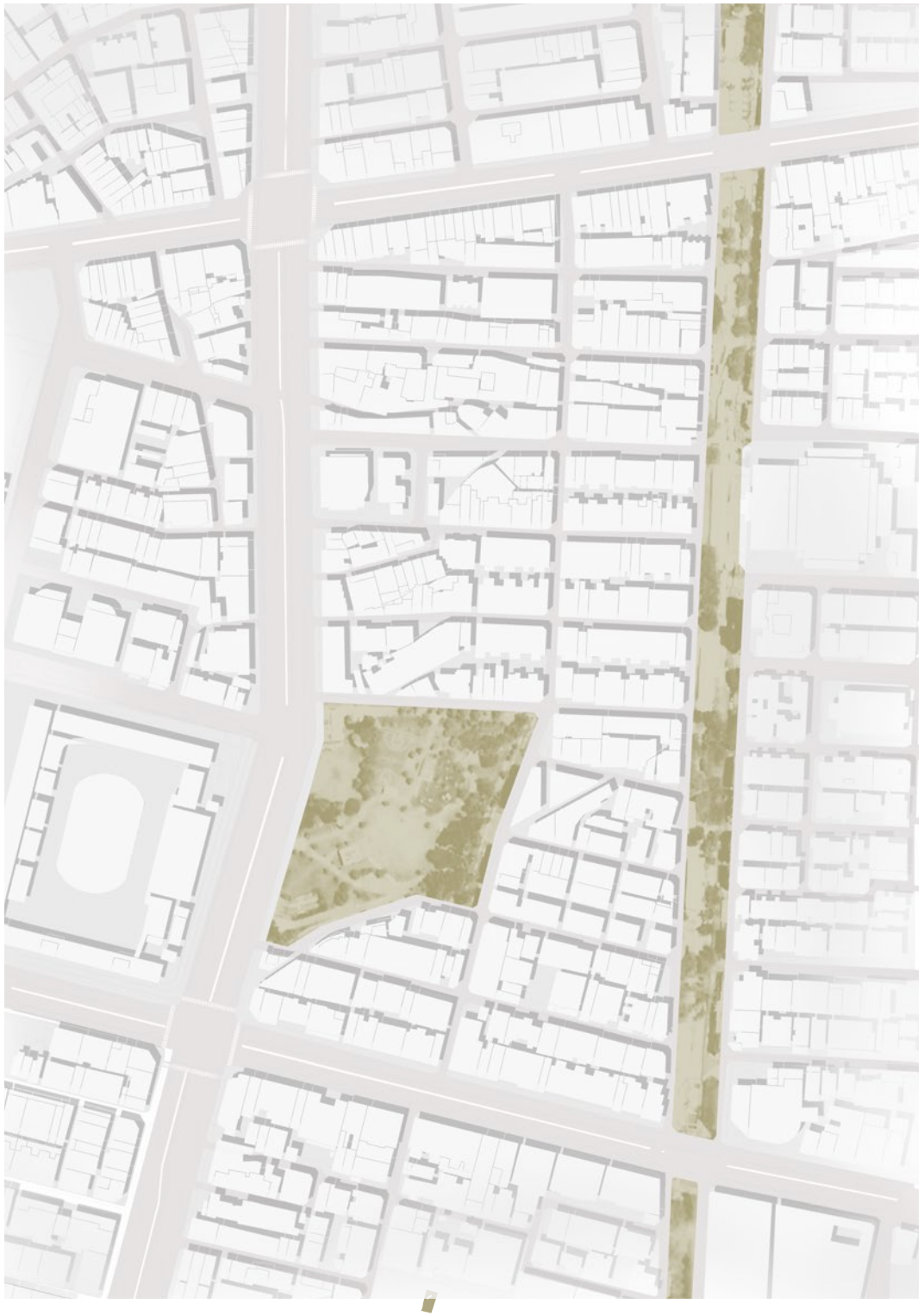
In addition to the site location of the temporary houses, the design of the temporary houses should also consider about the functions. The original buildings are mainly shops and residents, as a result, the solutions is to leave the ground floors for shops and other floors for the residents.

The key strategies of the renewal design are categorized as three aspects and followed the principles to develop the possible plans.

- **Open space:** according to the typology analysis, the open space needs to be improved in the area. Therefore, the distribution is following the current open space areas and enlarging them, as well as creating more scattered social points follow the local social context (for example, create small squares beside temples).

- **Streets:** to deal with the problems of narrow lanes with illegal parking in the streets, which makes them inaccessible for fire engines during emergency, the vehicle-free zones is adopted in the area. To create a better environment in the site without sacrificing convenience, the parking towers are added surrounding the site. Moreover, scooters should be considered seperately as they are the most important vehicles for people in Taiwan. As a result, circulations are divided into three systems: accessible for car, scooters, bikes, and pedestrians (outside the neighborhood), accessible for scooters, bikes, and pedestrians (partially inside the zone, scooters can be parked in the parking lots), and bikes/pedestrians only.

- **Buildings:** the design aims to follow the social context, keep the same capacity for the resident moving back (at least 421000m^3) and create more space for social interactions. In the design, the historical buildings are preserved, and more open space in the area. Moreover, in the details of the buildings, there is more space for social meeting points. The concepts are illustrated on the next pages.



Plan A

pro connect the parks
con less small social interaction point

Plan B

pro more social interaction points
con open space are not connected

Plan C

pro more social interaction points and connect the open space.

Current Buildings
Renewed Buildings
Historical Buildings

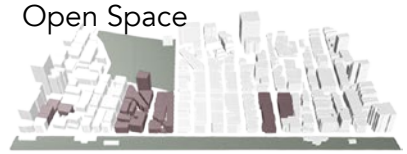
Open Space
Temple Plaza

Cars
Scooters
Bikes/Pedestrians

Bike Parking Lot
Parking Tower

Phase 0

Phase 1 :
Open Space

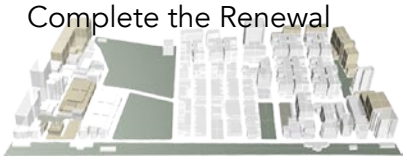


Phase 2 :
Main Street System

Phase 3 :
Minor Street System

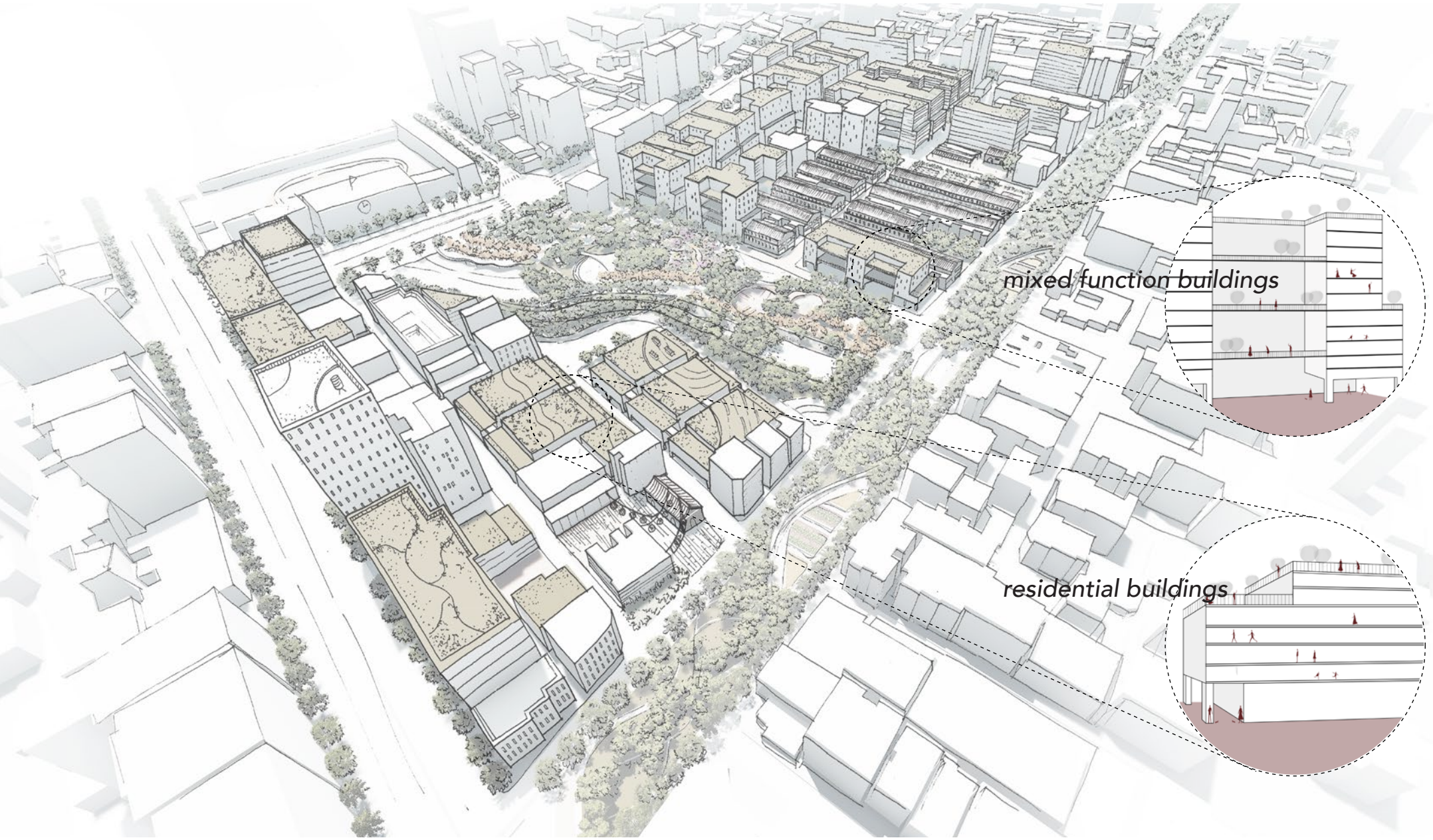
Phase 4 :
Other Old Buildings

Phase 5 :
Complete the Renewal



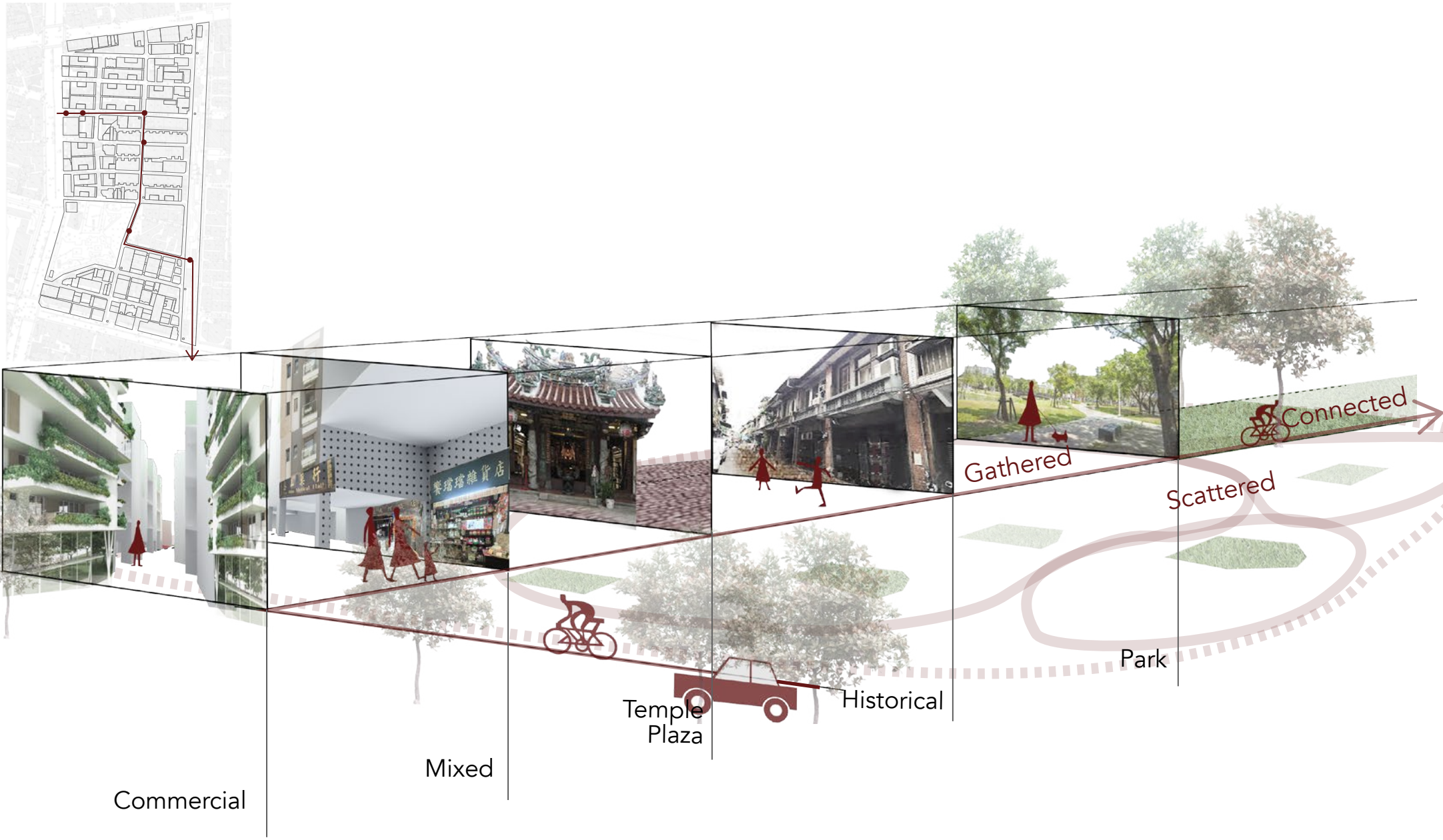
Bird-eye View

The renewed buildings are considered not only safer structures but more open space for the residents. Moreover, the buildings can also function as corridors for the hot and rainy weather here.



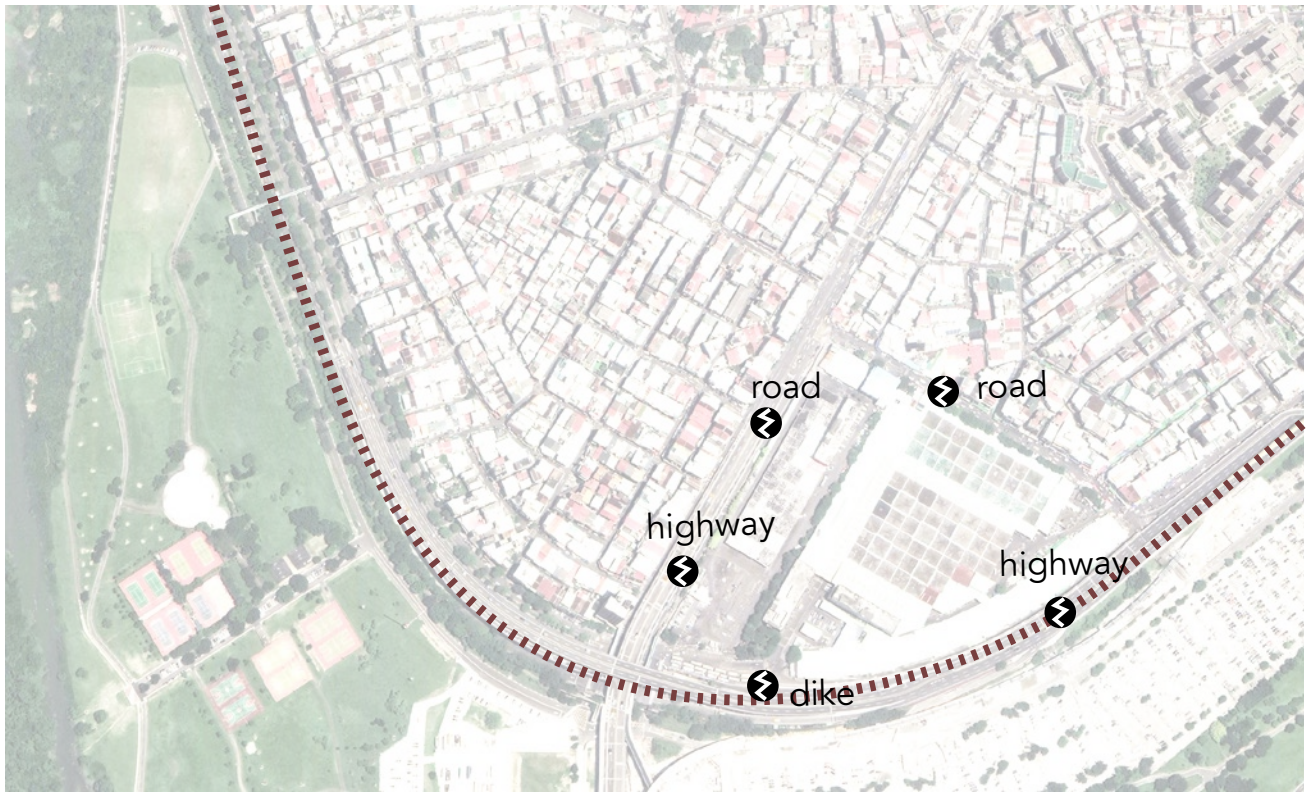
Walking experience

The diagram shows the walking experience on site. Starting from the outer area, commercial buildings with green infrastructures create a modern and green impression of the city. Then, while following the path into the neighborhood, a lively and cultural environment appears. The mixed function buildings provide social interaction points with shelters and corridors for social life even in burned summer and raining seasons. The temple plazas provide not only cultural activities but temporary refuges during emergency situations. The historical buildings are preserved to strengthen the place attachment for the residents. The community park is not only a playground for children but a relaxing green paradise for people who live here and it also creates a wider space for disaster prevention usage. Last but not least, the neighborhood is surrounded by the urban greenway, which connects to the sustainable transportation systems in the city.



Type2 Demonstration

The area has no open space inside and the riverfront park is blocked by the dikes. Apart from the segregation problems caused by highways, dikes, and the main roads, the center of the neighborhood is a wholesale market, which is now too old and messy. Also, because of the wolesale market, there are some small open markets around which cause a lot of traffic and environmental issues.



Open Market

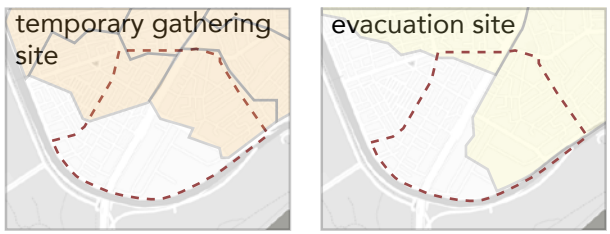
Wholesale Market

Site Analysis

In the type2 area, the open space goal is scattered and gathered.
The analyses according to the design principles are as below:

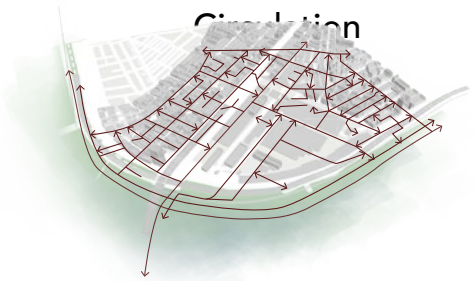
Open Space

open space | Riverfront only



Scattered
Gathered

Circulation



cars/scooters/ bikes/pedestrians | Car Prioirity

Street Accessibility

non-conformity
conformity

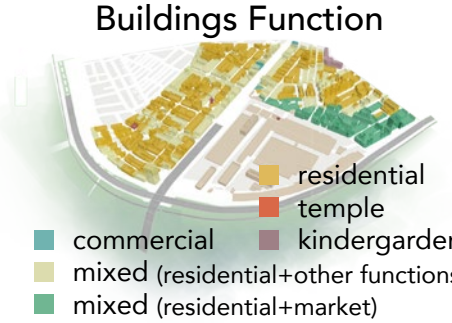
Building Quality

bad (>40 yrs)
improvable (30-30 yrs) | non-quakeproof
good (<30 yrs) | quakeproof

Infrastructure

highway
dike

Buildings Function



residential
temple
commercial
kindergarden
mixed (residential+other functions)
mixed (residential+market)
market

Design Process

The key strategies of the renewal design are itemized as three aspects:

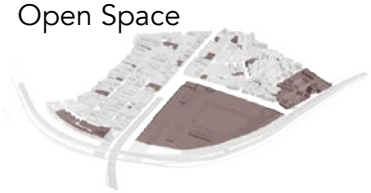
- **Open space:** the open space pattern, which is gathered and scattered, needs to be improved in the area. Since there is no open space in the area currently, by following the social contexts, the scattered squares are served as open markets to deal with the current issues, and small parks are designed in potential space after removing the old buildings. As for the gathering space, the current market area has the potential to be renewed as a green-roof architecture be the way to cross the dikes.

- **Road systems:** the circulation is divided into three systems as well, in the site: accessible for car and scooters, accessible for scooters, and pedestrian only.

- **Buildings:** in the design, the buildings are also renewed, in order to solve the segregation between the riverfront and the neighborhood, as well as create more open space. The detail are illustrated on the next pages.

Phase 0

Phase 1 :
Open Space



Phase 2 :
Main Street System

Phase 3 :
Minor Street System

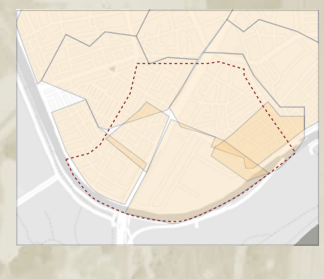
Phase 4 :
Other Old Buildings

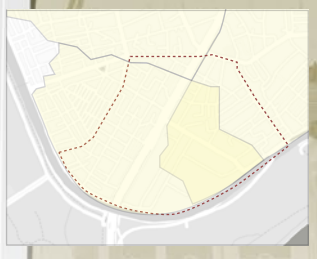
Phase 5 :
Complete the Renewal

- Current Buildings
- Renewed Buildings
- Open Space
- Square

- Cars
- Scooters
- Bikes/Pedestrians

- Bike Parking Lot
- Parking Tower

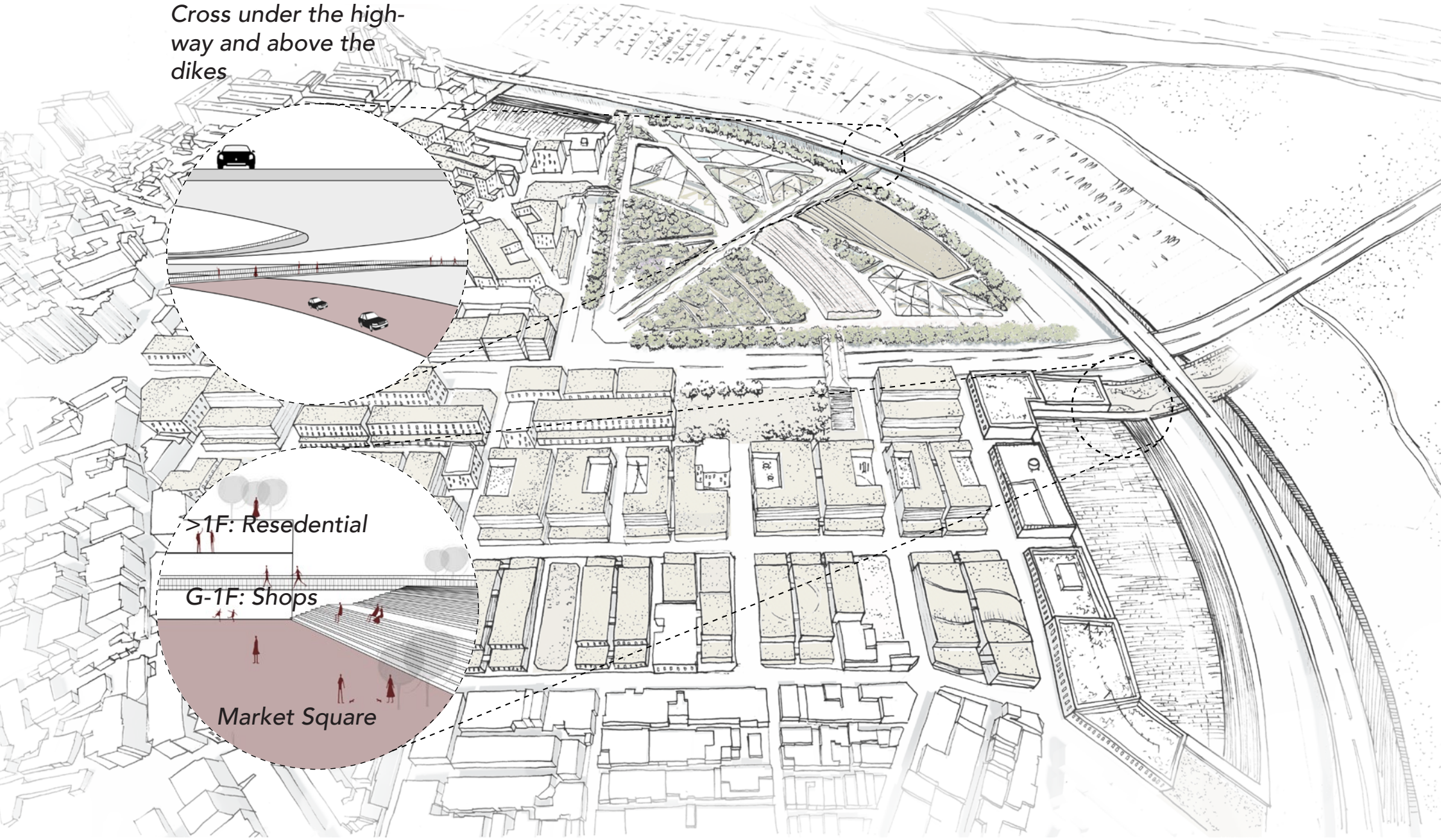




0 200m n

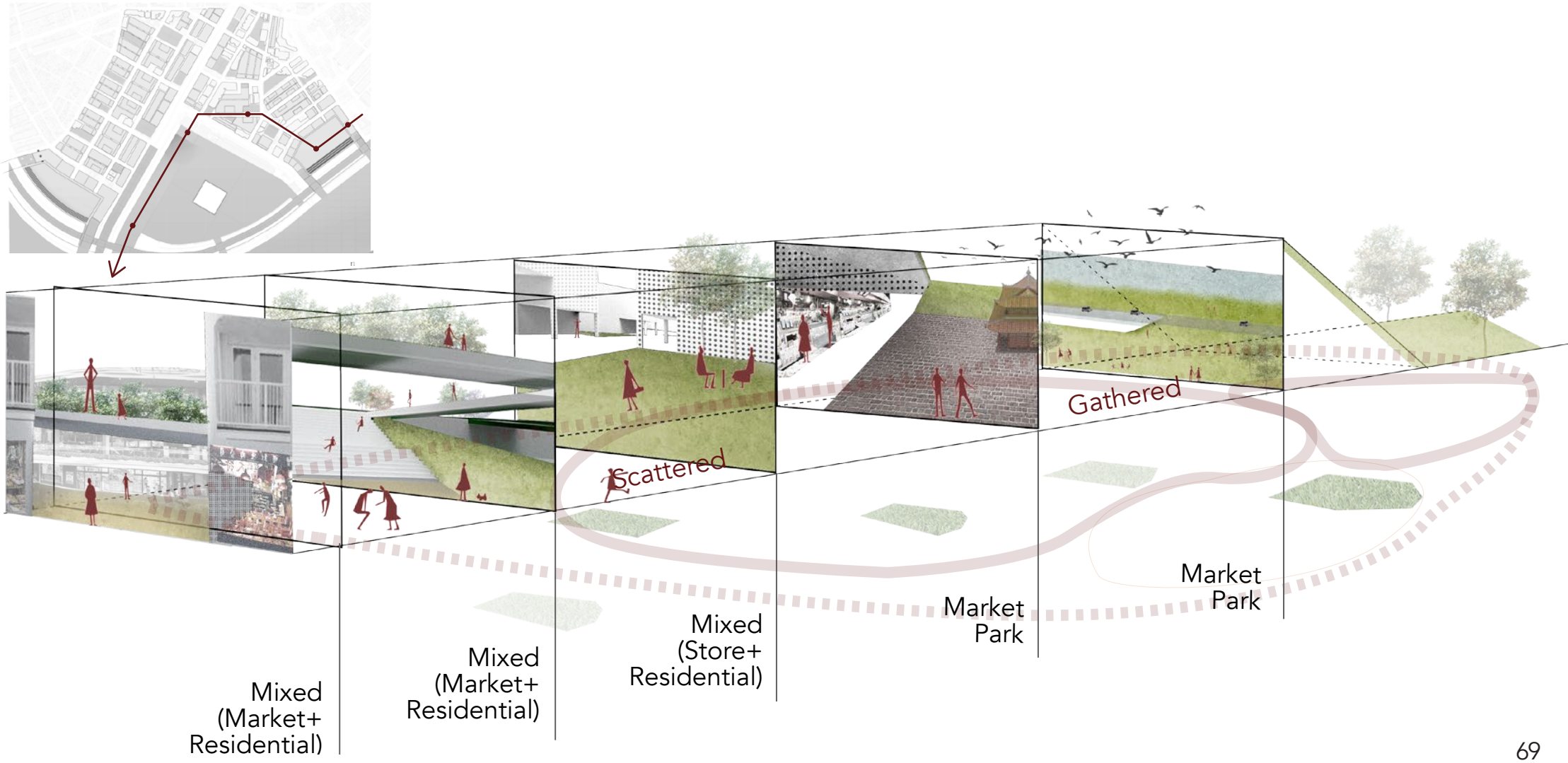
Bird-eye View

The renewed buildings are designed for increasing the open space and overcoming the segregations.



Walking experience

The walking experience on site. Starting from the market and residential mixed building, the market square creates a social space in the middle, stairs and slopes not only serve as connections but also seats for people to enjoy the foods from the markets. While moving deeper to the neighborhood, a quieter environment with scattered green space appears. Afterward, the big market appears, then the experience proceed on the green roof. Finally, after crossing the dike the riverfront is reached.



DETAIL SPATIAL DESIGN

Background Theory

The main goal of the project is to create “safety and livability”. As a result, the detail spatial designs should also consider both purposes. Therefore, the list of required park elements for prevention parks (Wang, 2000) was adopted, as well as the survey of park preference of Taipei citizens. Later, both the requirement types were translated into a series of design tools for practical design.

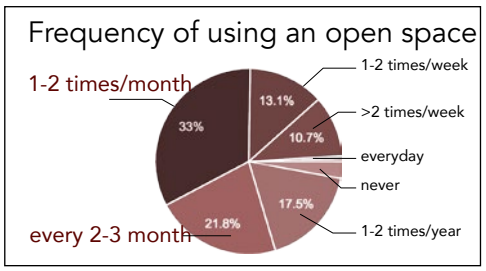
Emergency

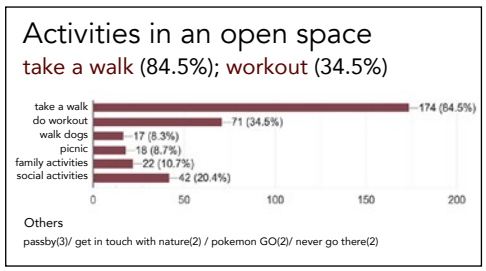
(Wang, 2000)

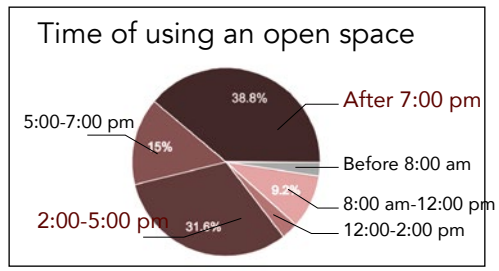
Facility		Purpose and consideration factor
Circulation Plaza Others	Entrance	Entrance and exit wide >20m More than one entrance and exit Entrance next to the square
	Surroundings	Accessible and safe for people
	Plaza	Suitable for tents or temporary housing
	Route	Fluent for people and vehicles Connected to the surrounding roads and the squares in the park
	Helipad	Existing squares in the parks
Parking lot		Disaster relief and refuge vehicles should be divided
Planting		Fire and wind resestance
Water	shatter-proof tank	Waterscape and water purification system Nearby hydrants or open water
	emergency tank	
	fire hydrant	
Toilet		Dispersed in the refuge space
Supporting facility	broadcast system	
	communication device	
	emergency sign	
Lighting system		Alternative energy sources (ex. solar energy)
Power		
Warehouse		Shock-resistant and fire-resistant structure
Administering station		Park maintenance an emergency station

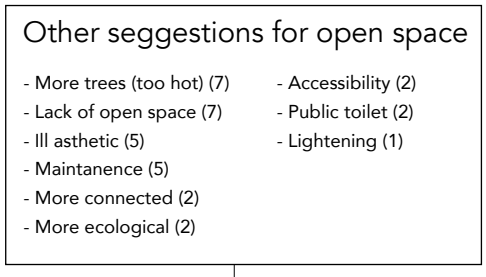
Living Quality

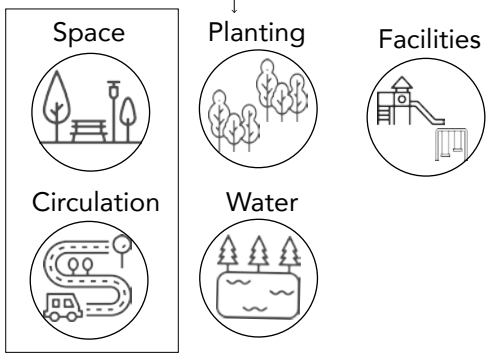
Urban Open Space Survey



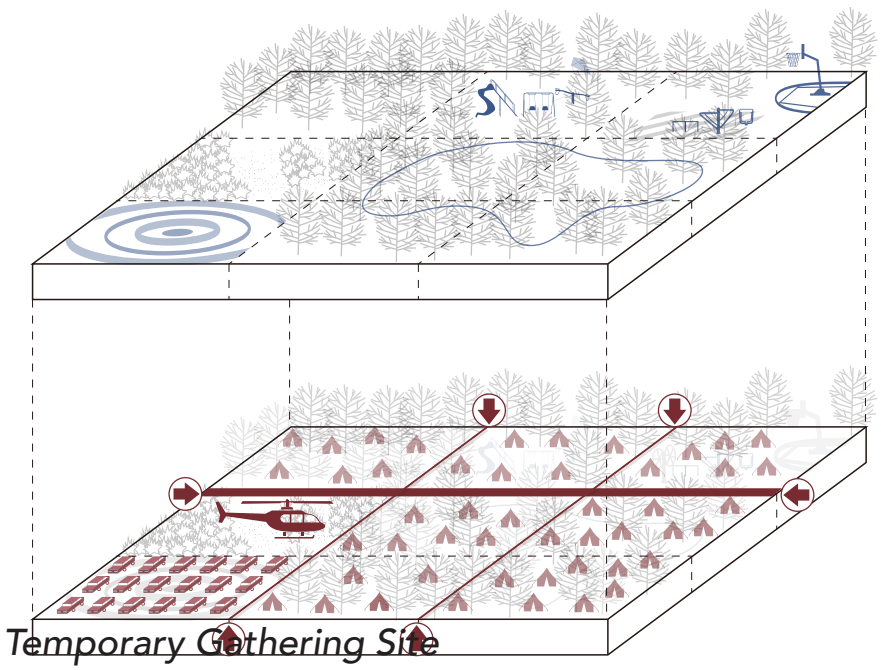








Space & Circulation



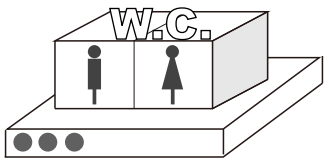
- Different experience and muti-functions for leisure activities
- More shaded area

- Clear main routes for vehicles
- Enough space for camp sites (shaded area)
- Enough space for parking (open area)
- Open area for helicopters (open area)

■ Daily Life
■ Emergency

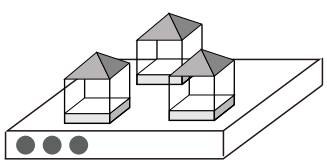
Facilities

Toilet



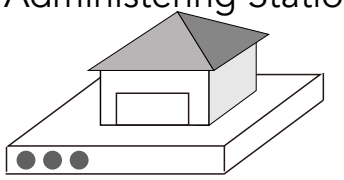
* Spread inside the site

Warehouse



- Suppliments
- Cafe/Pavilion

Administering Station

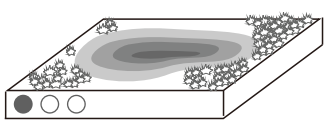


- Adminstering Station/Health aid
- Activity Center

* Alternative energy collection

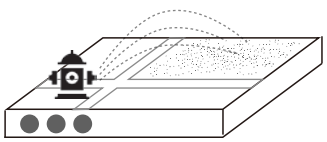
Water

Pond/ Swimming Pool



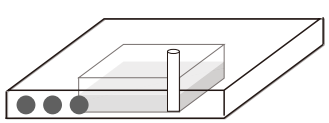
- Water
- Leisure

Fire Hydrants



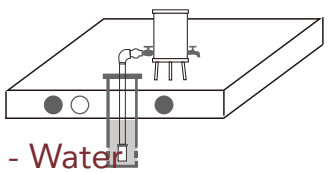
- Water

Underground Tank



- Drinking Water

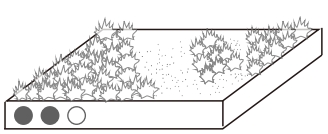
Underground Pump



- Water

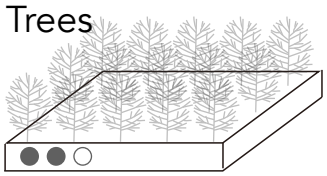
Planting

Lawn / Farm



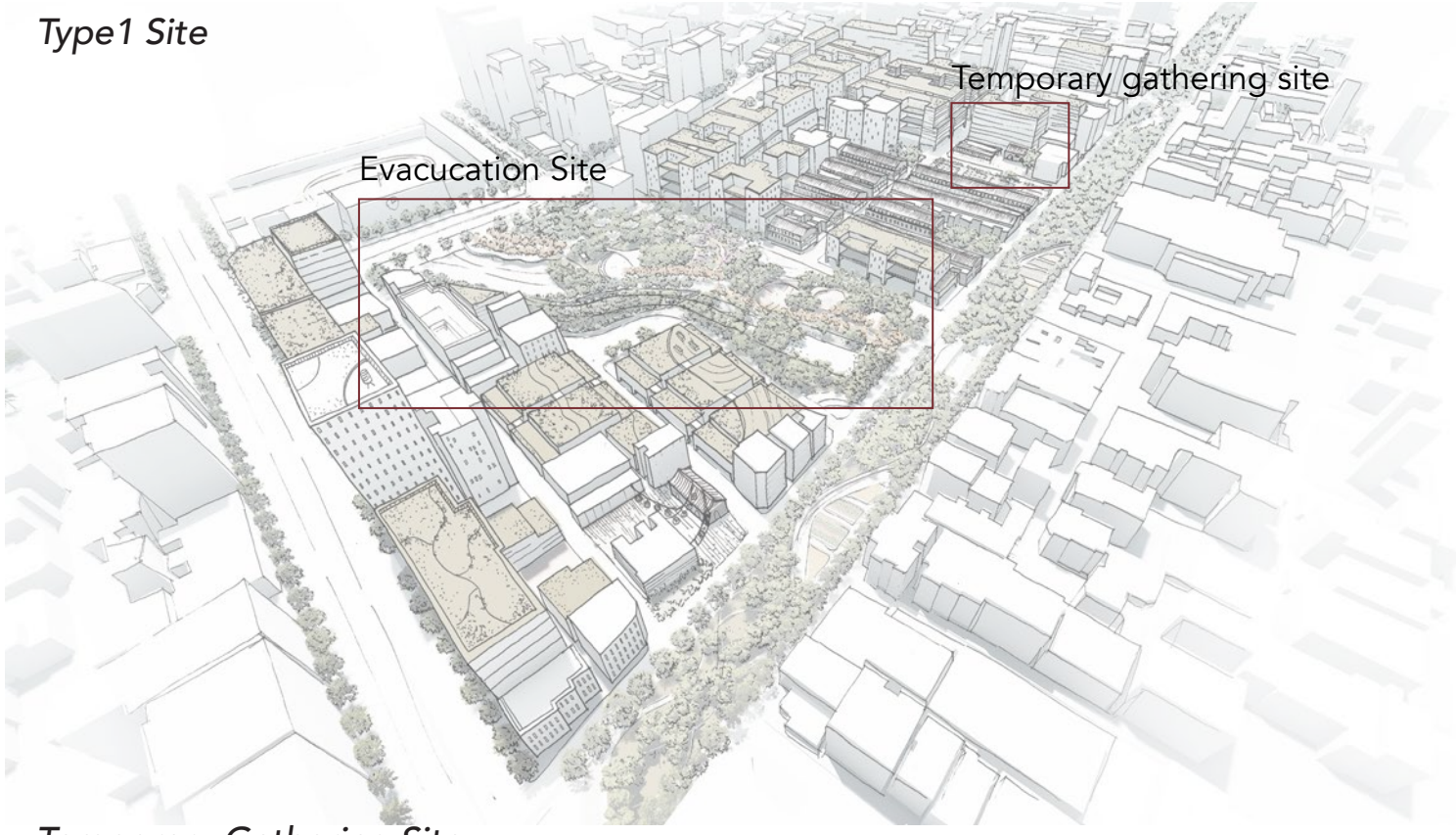
- Camp Site
- Leisure

Trees



- Fire Barrier/Camp Supporter /Air Purify
- Leisure/Shaded

Type1 Site



Watch video

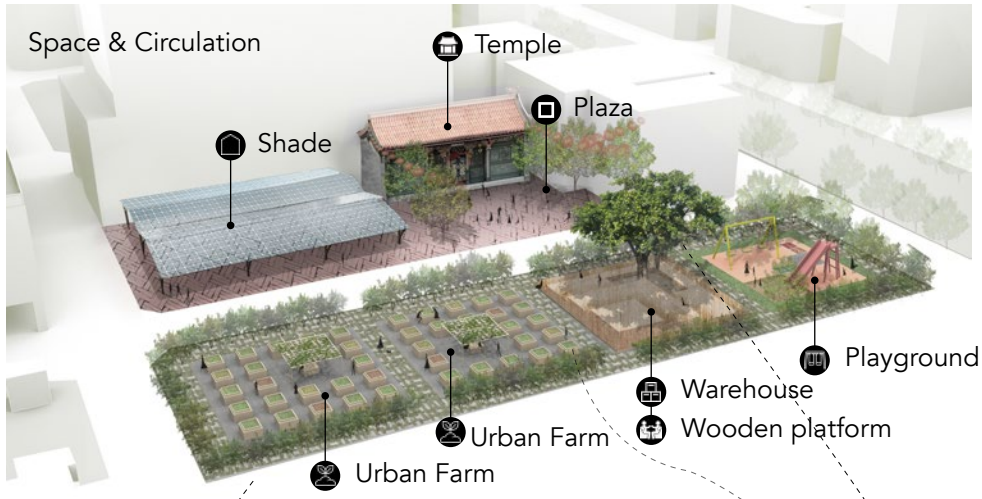
Temporary Gathering Site

refugees in the service area: about 560

maximum refugees in the temporary refuge: 550-650

Daily Life

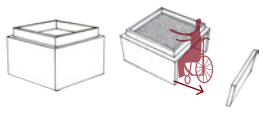
Space & Circulation

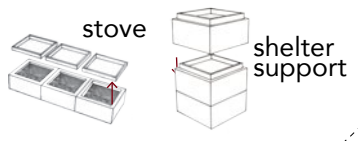


Emergency

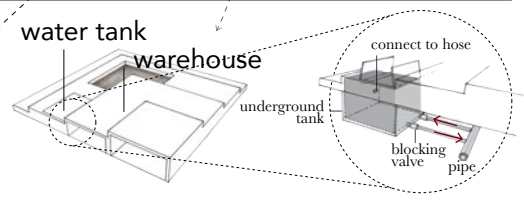
Facilities

planting bed (disable friendly)





Water



Planting


Taiwan adinandra


Chinese Photinia

soft boundary
- shurb
- shade tolerant

fire barrier
- high moisture
- low oil content


Autummn Maple Tree


Marabutan


Taiwan Golden-rain Tree

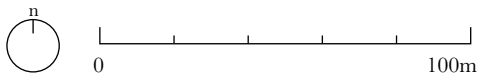
shade
- large crown

against quakes
- deep roots

Evacuation Site

rufugees in the service area: about
1500-2500

maximum refugees in the evacuation site:
2620



The space is open from the front road and creates closer space in the middle provides different experiences. As for the circulation, it leads people to the linear park on the east.

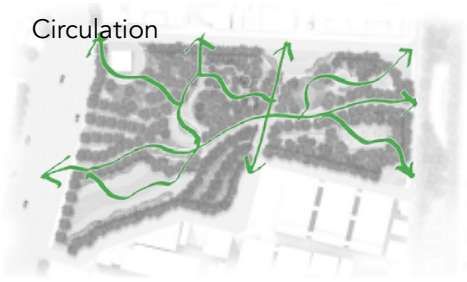
If an emergency happens, the trees around create a fire barrier, space is organized with different functions, and the routes are wide enough for transportations.

Daily Life

Space

- Open on the side of the main road
- Dense trees provide shaded area

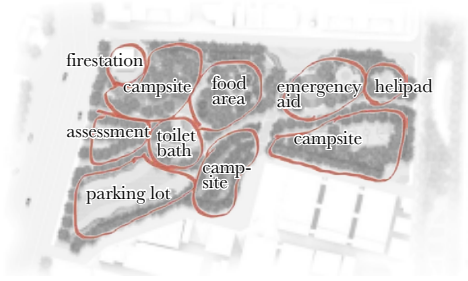
Circulation

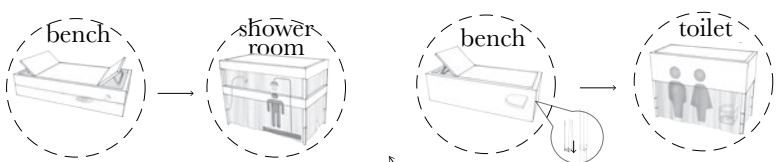


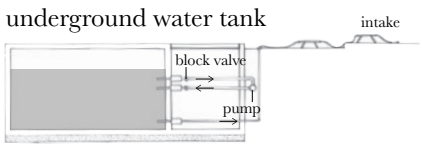
people
car

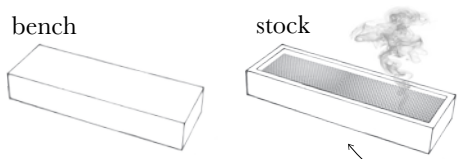
Emergency

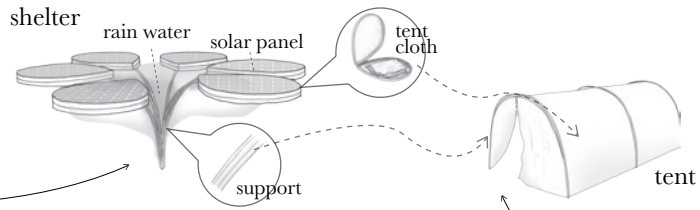
- Fire barrier




bench
shower room
bench
toilet


underground water tank
intake
block valve
pump


bench
stock


shelter
rain water
solar panel
tent cloth
support
tent

playground

medical aid

outdoor cafe

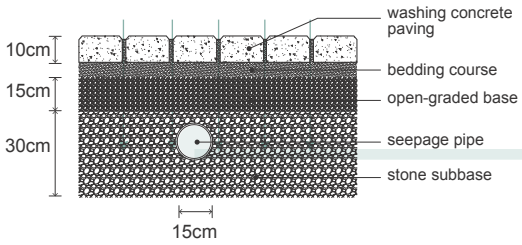
water square

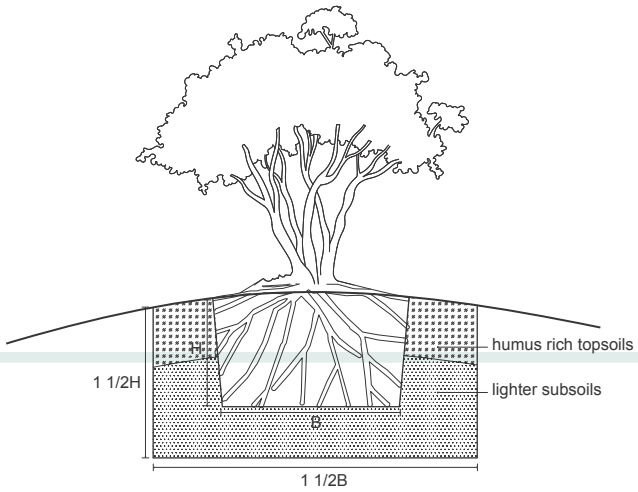
assemble square

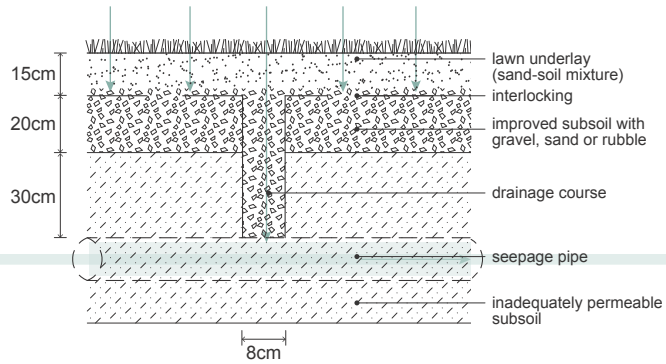
helipad

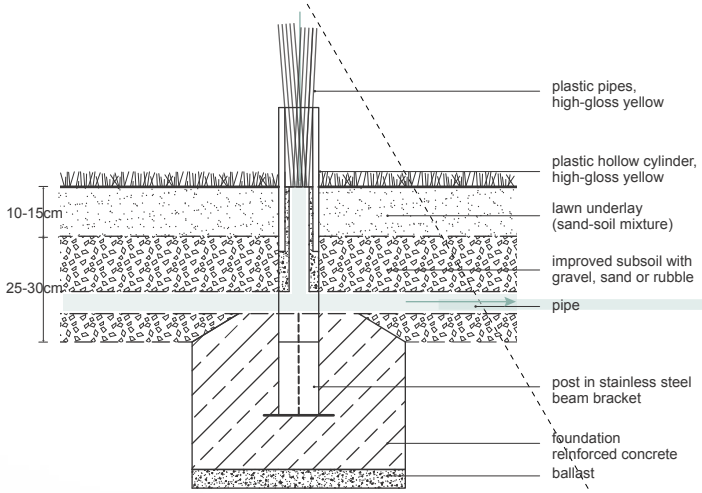
Construction Details (water systems)

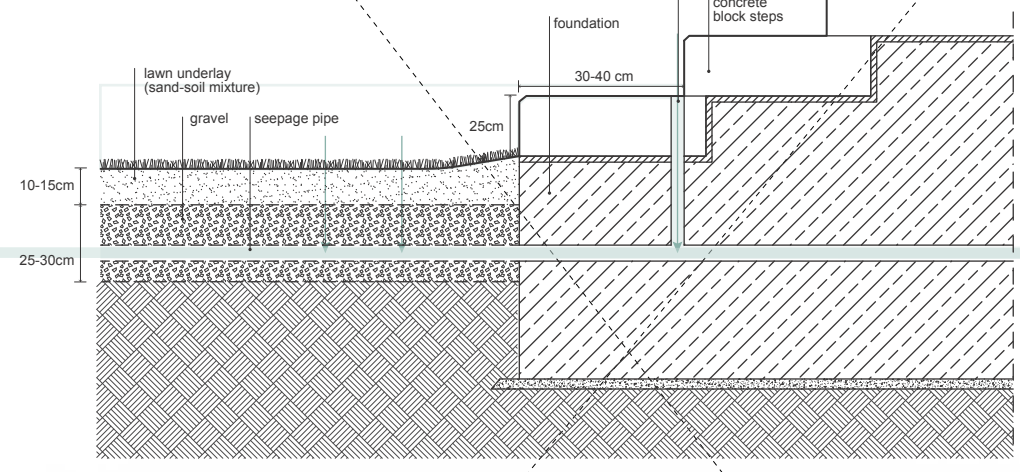
There are two main water systems in this design. Firstly, the permeable surfaces and the designs collect the rainwater and connect to underground water filter for watering usage. Secondly, the clean water system for the water square comes directly from the pipes, also, during the emergency, it can be served as drinking water.

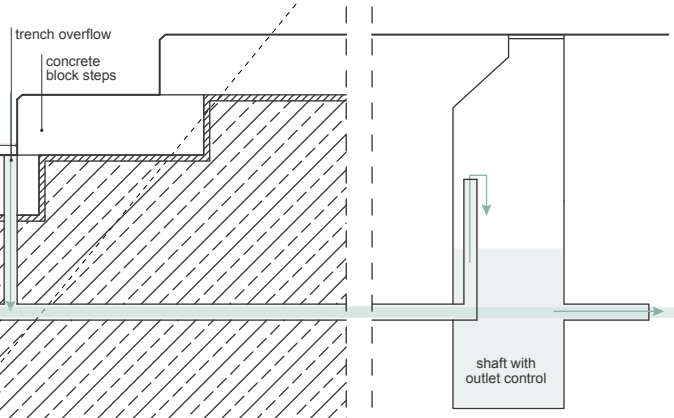


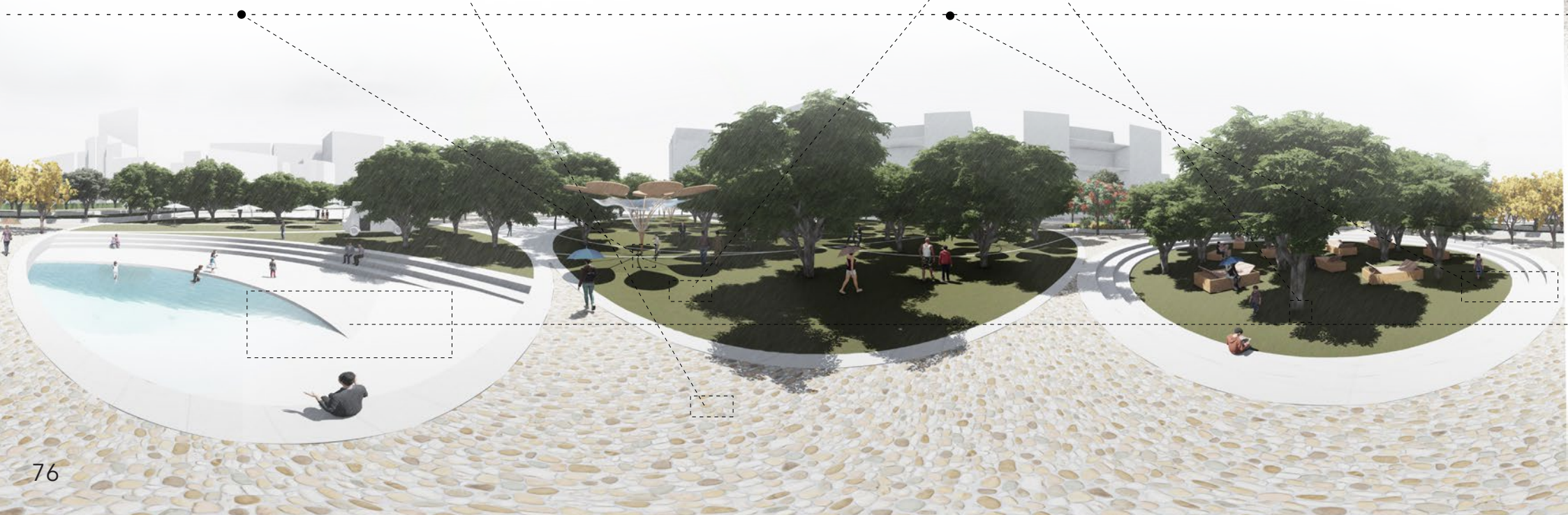




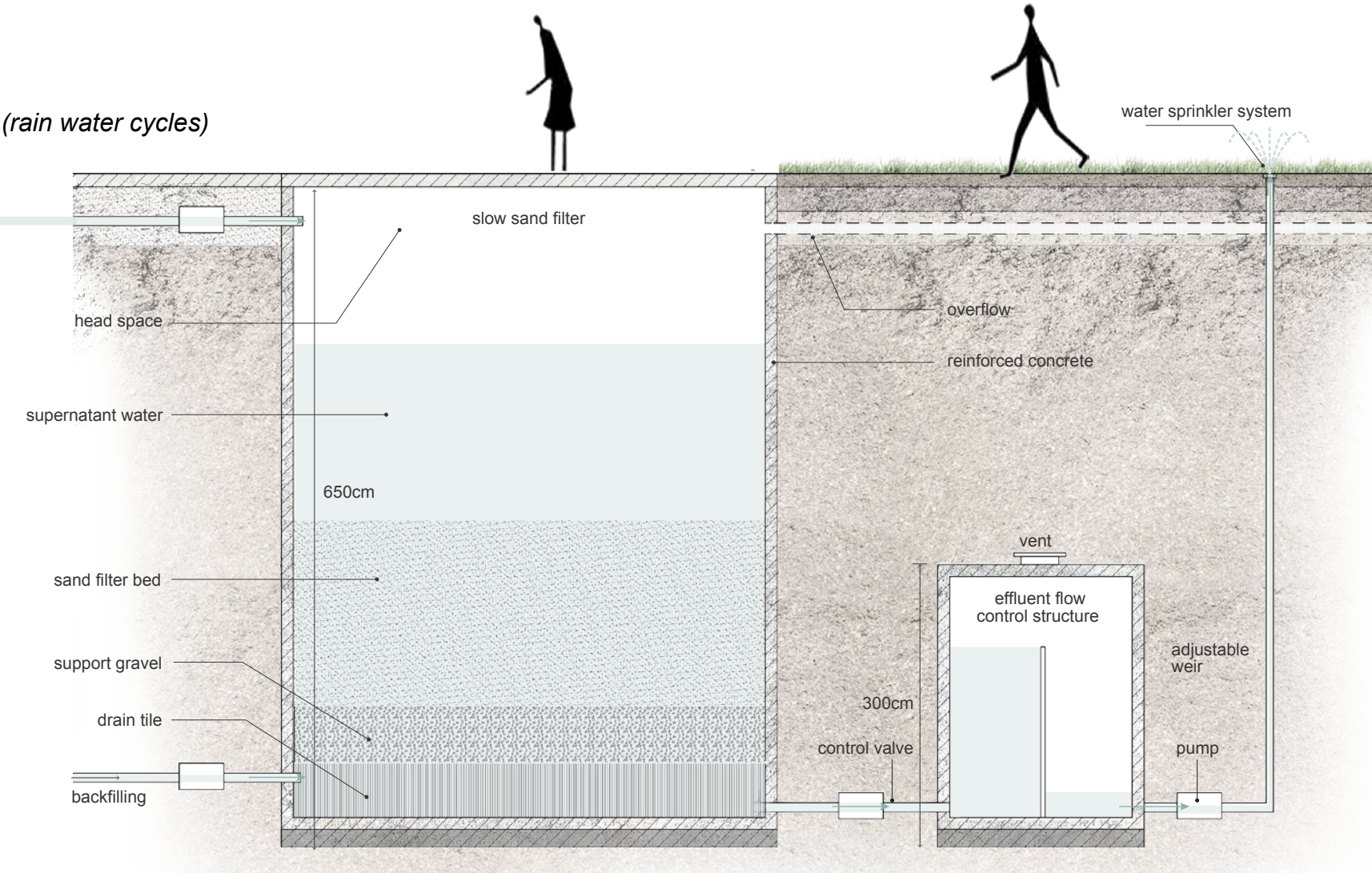




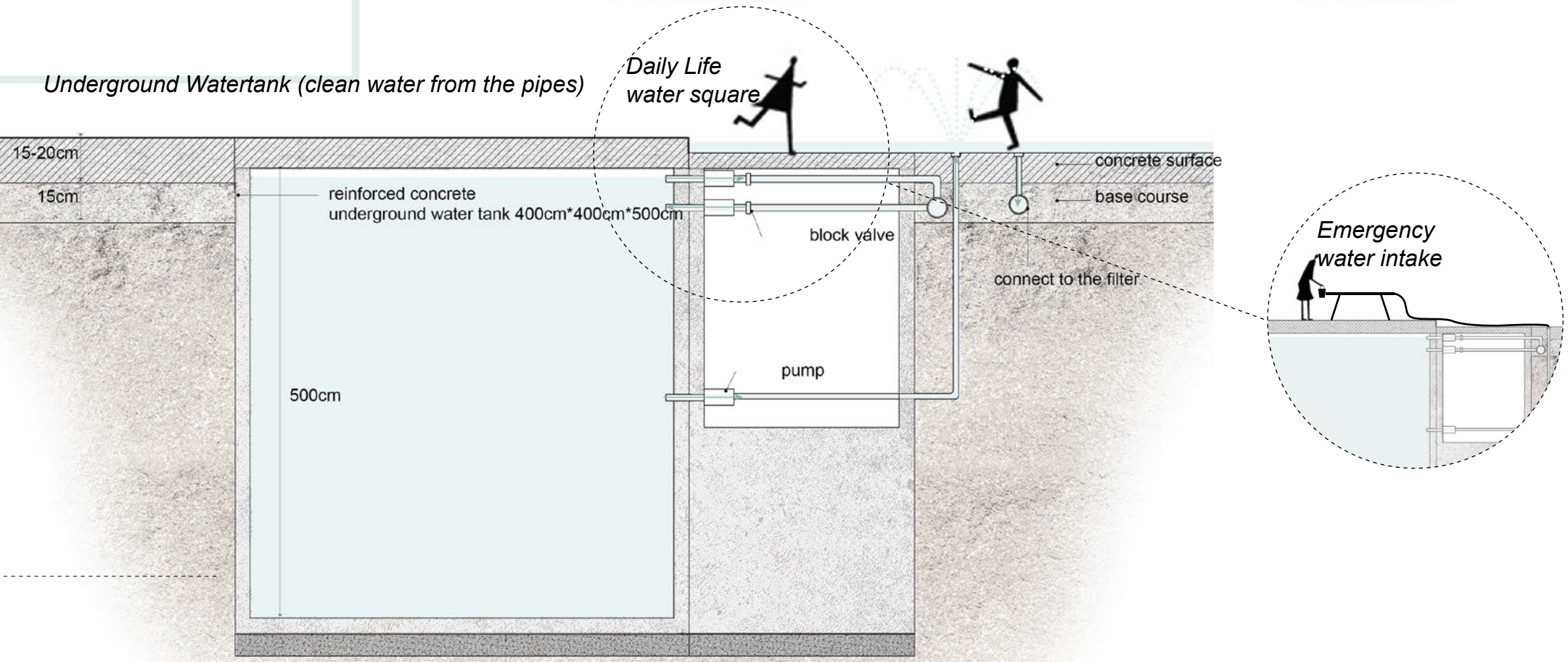




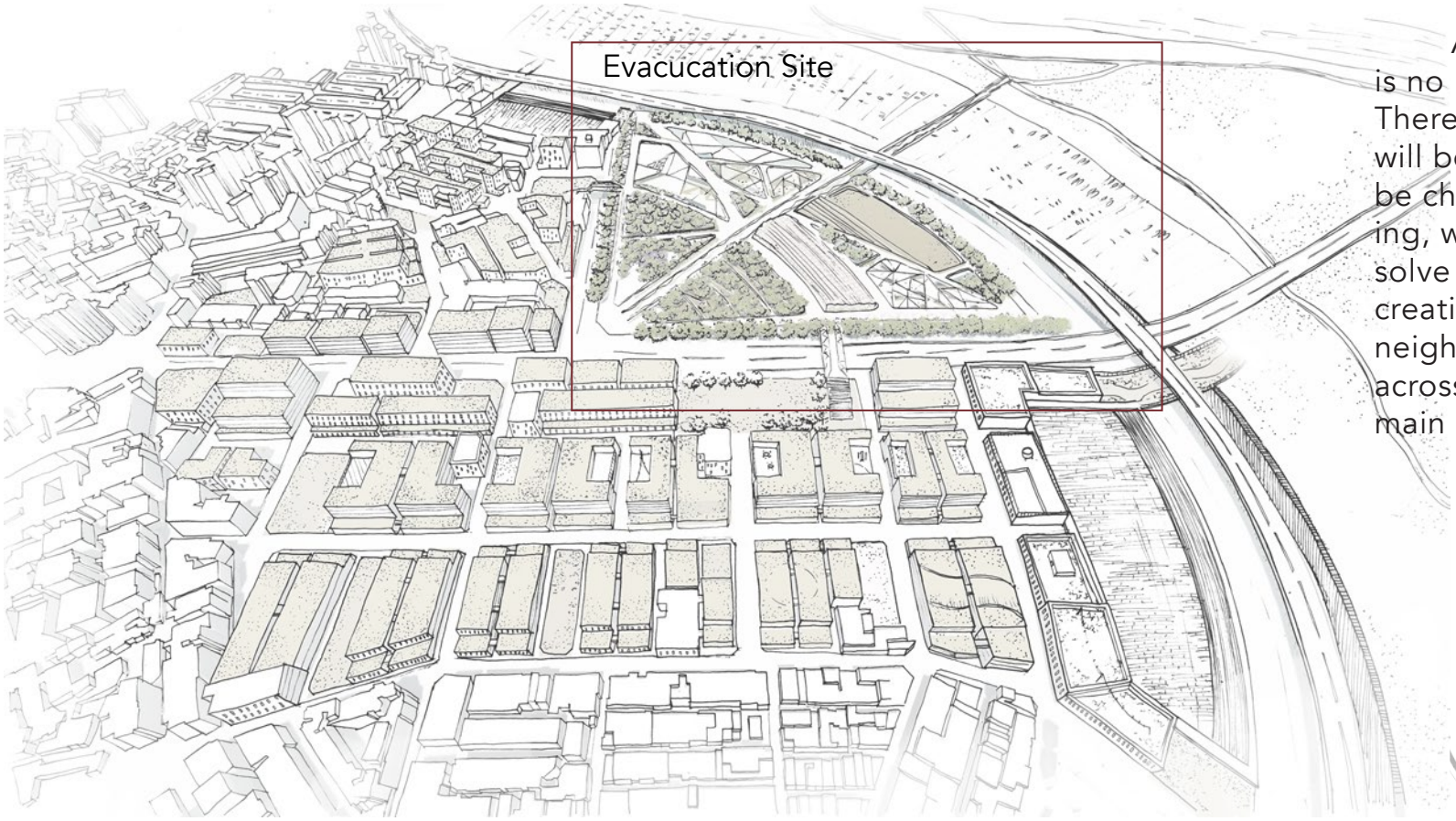
Underground Water Tank + Filter (rain water cycles)



Underground Watertank (clean water from the pipes)



Type2 Site



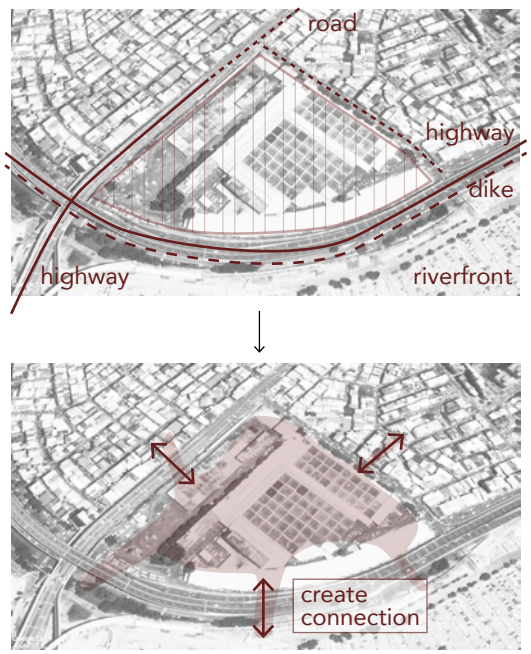
As mentioned before, there is no large open space in the area. Therefore, the old market, which will be renewed, has potential to be changed as a green roof building, which is also expected to solve the segregation problem by creating a connection between the neighborhood and the riverfront across the dike, highways, and main roads.

refugees in the service area: about 6000-6500

maximum refugees in the temporary refuge: 7000

Problem Statement

Problem of segregation



Problem of the market

Not enough space

Old structure (since 1960)

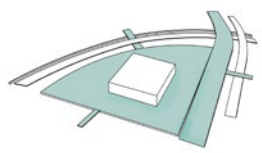
	current situation	preferable situation
vegetable	9927 m^2	16843 m^2
fruit	8363 m^2	12465 m^2
seafood	866 m^2	1443 m^2
total	19156 m^2	30751 m^2

160%

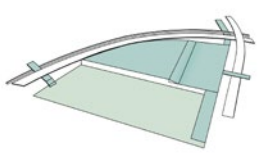
(Taipei city government, 2017)

Experiments

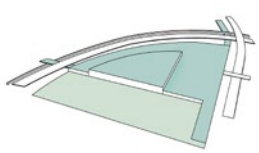
green roof
park



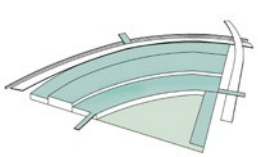
Can't plant big trees on the greenroof with deep roots.
(small trees might cause danger during quakes.)



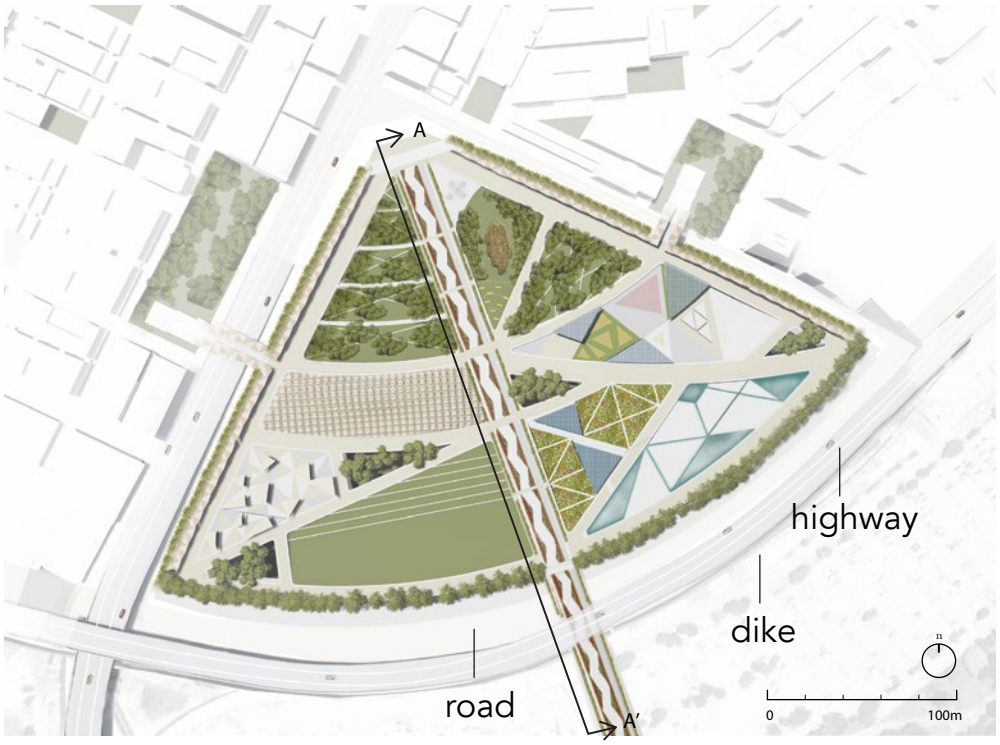
Huge vertical section be seen from the river side.



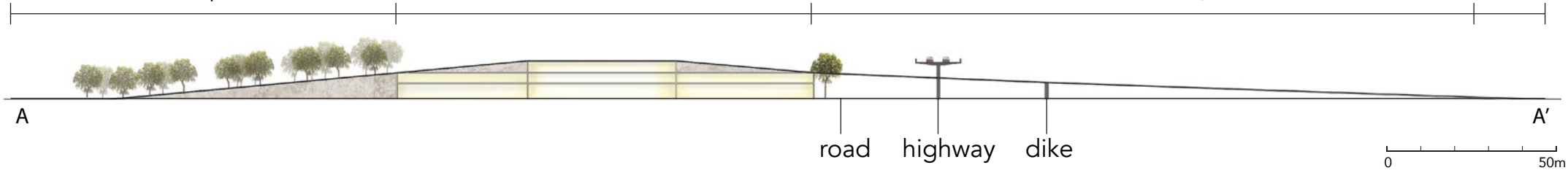
Can't connect to the other side.



Final decision.



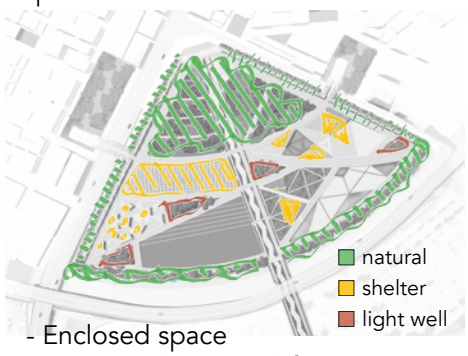
Slope | Market | Bridge | Riverfront

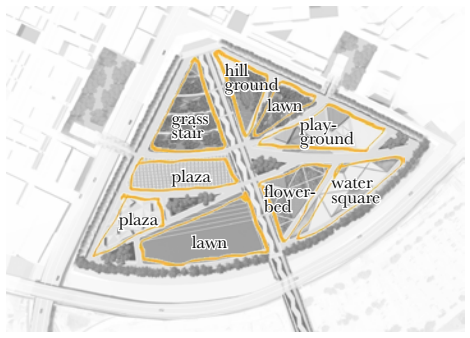


One of the big challenges in the design is to create a shaded area to adapt to the hot weather in Taipei. However, it is hard to plant big trees on rooftops, and the small ones might be not able to resist the earthquakes. Therefore, the trees are planted on the north part which is a slope with solid ground, then the rooftop uses shelters for the shadows.

Peacetime

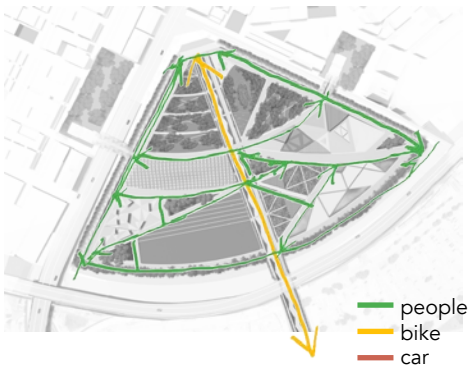
Space



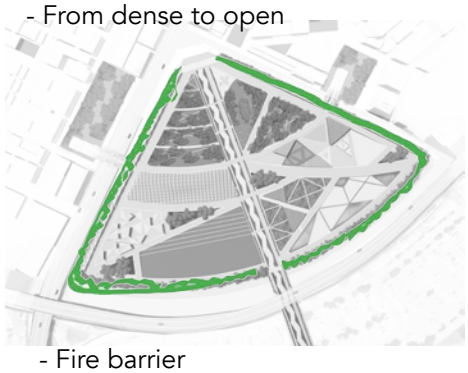


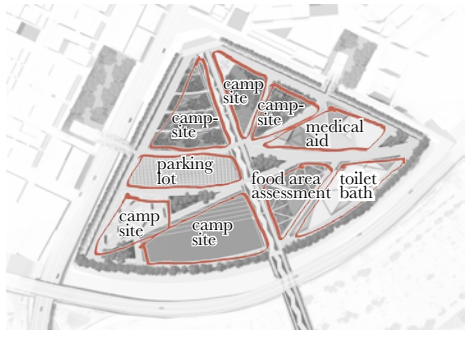
- Enclosed space
- Trees on the ground floor
- From dense to open

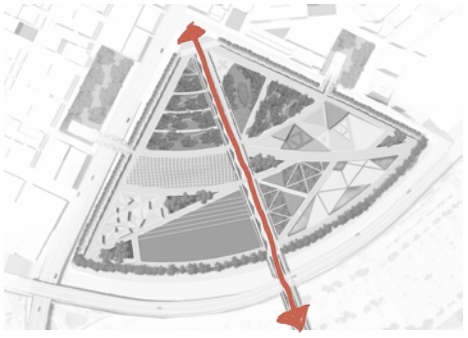
Circulation



Emergency

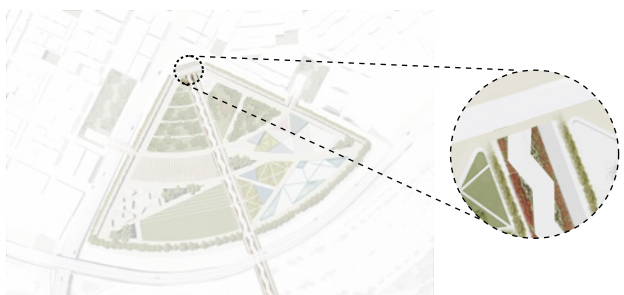






- Fire barrier

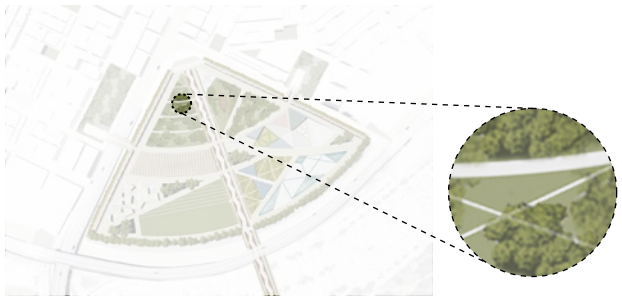
The picture on the right shows the wholesale market under the green roof. With the light wells, sunlight passes through the trees and makes the market not only brighter but also more lively.



The middle path is divided for pedestrians and bikes in order to connect to the bike path on the riverside. Also, the road is wide enough for emergency situations.

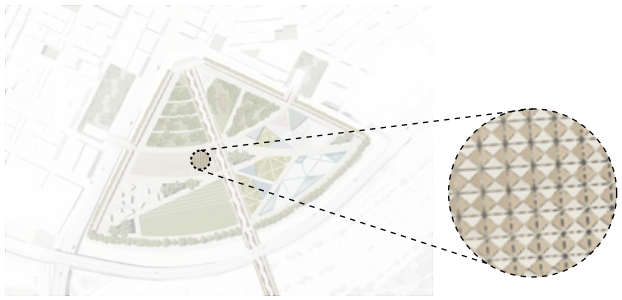
Axis

Transportation route



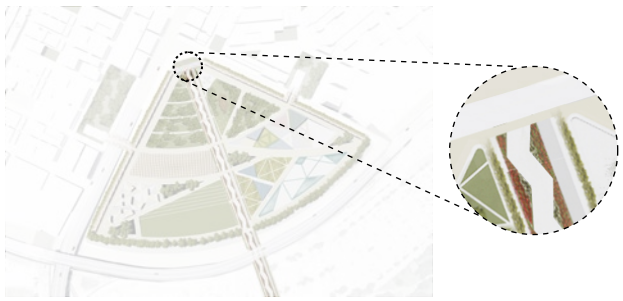
Grass stair

Campsite



Shelter

Parking lot



Flowerbed

Food storage and cooking area

07

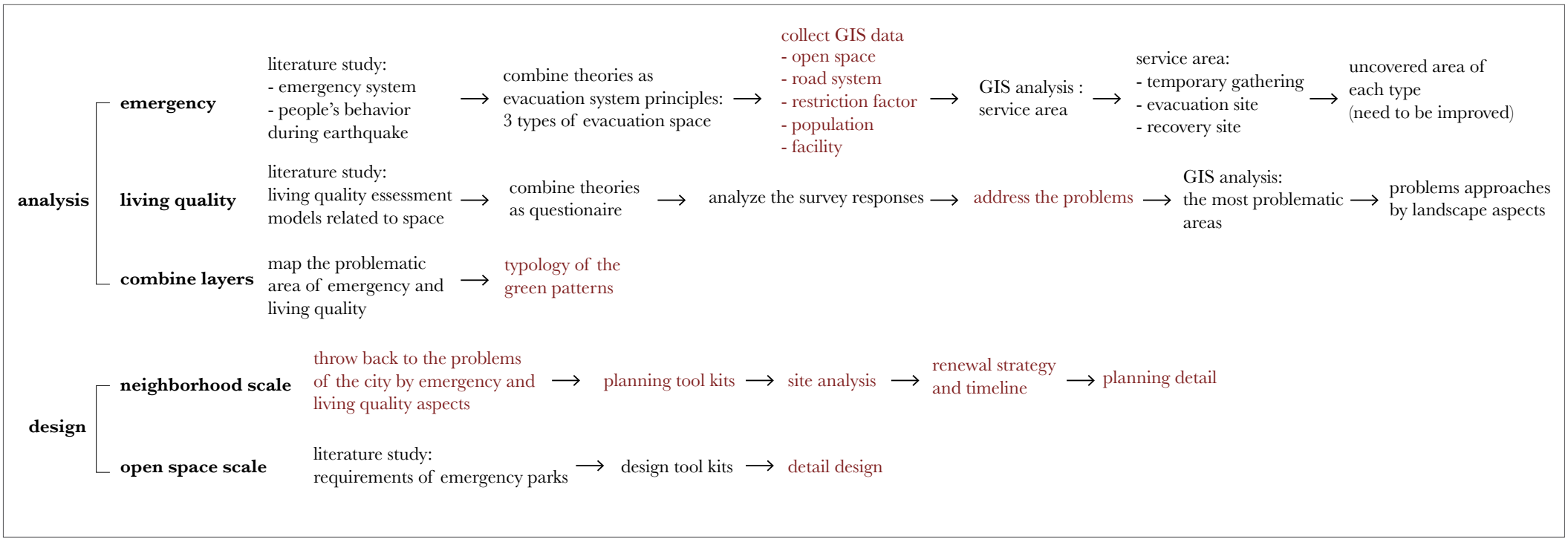
- Conclusion
- Lesson learned
- Relevance

REFLECTION

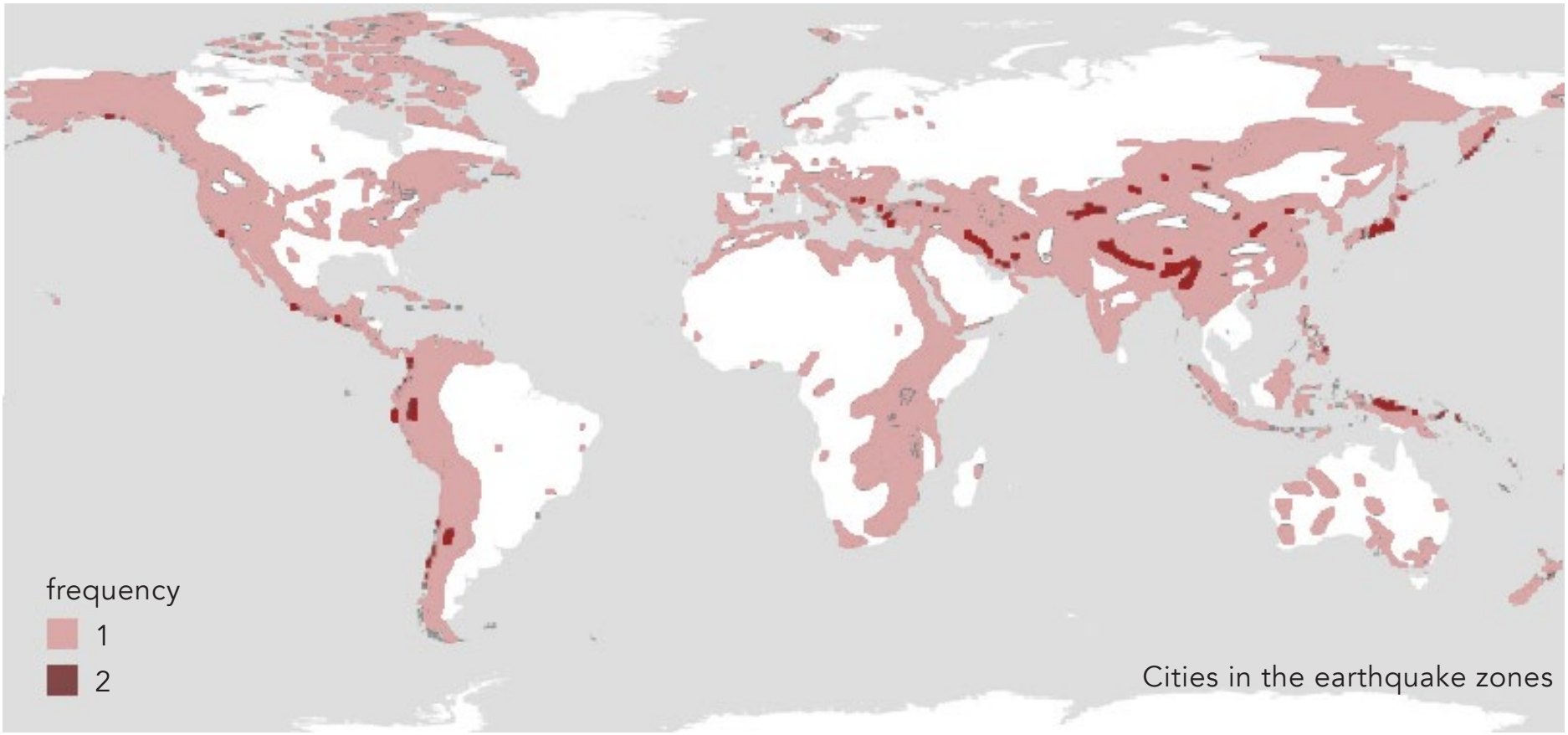
How can we apply these design principles in different cities?

Earthquakes always cause dramatic problems in cities in the earthquake zones; therefore, it is crucial to design these cities with this awareness in mind. This project explores a new design thinking of open space distribution for both emergency and in normal life. During the process, the thesis provides the possible ways to measure and analyze the current open space and design interventions to approach the goal.

As a result, the first step of this thesis reflection is to run through the whole process of planning and design, in order to find the general principles which can be applied to other cities. The process and methods that were used are shown in the flow chart below:



Since all the principles are collected through scientific methods, the work flow is valuable for other sites. However, the site specific data (label as red in the chart) can be different in different cases.



Did the design answer the research questions?

The main design question in this thesis is: what are the landscape interventions that can create a safe and livable city? Afterwards, this question led to three sub-questions, which are answered in short below:

1. What is the open space system for evacuation during the earthquake?
   Open space system for evacuation can be divided into three types: temporary gathering site (0-3days), evacuation site (3days-1month), and recovery site (>1month). Different types of open space have thier own requirements due to different situations and time periods. Also, the routes, facilities and restriction factors around the evacuation space are considered as well.
2. What kind of open space system in Taipei City can improve citizens' living quality?
   By literature research and survey, the spatial quality problems are organized and they can be solved by two strategies: urban renewal and green infrastructure. Therefore, by analyzing and making scenarios of the problematic areas, the landscape is formed.
3. How to combine the emergency and living quality layers to create a safe and livable city?
   Mapping the two layers allows to define a series of typology that shows the locations and features of the landscape improvements. Also, the mapping declares the requirements design principles for both situations. With these informations, the designs can be zoomed into spatial levels, to apply the principles for both emergency and living quality.

Relevance

Flowscape studio

This project was conducted as part of "Flowscapes", the one-year graduation studio of the MSc Landscape Architecture. The studio addresses landscape architecture design of green, water and transport infrastructures, considering them as armatures for urban development and for facilitating functional, social and ecological interactions. (Study Guide of the MSc Landscape Architecture TU Delft, 2018-19) This graduation project is focusing on the earthquake, which causes dramatic "Time Flows" as well as renewal process during the time.

Future proposals

Earthquake is an unpredictable natural disaster that will happen in the countries located in the earthquake zone. Therefore, it is crucial to reduce the damage as less as possible. This project can be thought as a beginning of rethinking open space, which should be considered not only for leisure but also an important role of evacuation systems, as well as the possible workflow to approach this goal.

However, due to the time limitation, it is impossible to apply the principles and fit to every specific area. Also, to form a quake-proof city by only open space improvement is not enough, the building structures, water systems, back-up electronic systems etc., also need the experts to be aware and involve. Therefore, this project is considered as a starting point, the proposed principles and designs can be used as tools for further updates and researches.

Lessons learned

During this one-year research and design process that led to this thesis project, several theoretical and practical issues, as well as the design process contributed to observations and new knowledge. The most important ones are presented below:

The evacuation system

The notion of reducing damage during earthquakes by open space aspects consists the main theme of this thesis; therefore, it is crucial to firstly set the standard for it, in order to continue with the analyses and design proposals. An emergency system, however, is much more comprehensive than I expected. It includes many different factors in space as well as time dimensions. In order to analyze, I tried to use ArcGIS to build some models and did experiments on them. In the end, I managed to apply all the factors I could find and imagine, and make them link with eachother by formulas to define the system. Most importantly, during the experiments, I have learned the methods of collecting and building such a massive database.

Layers-mapping design

At the beginning of the project, my concept was only about earthquake situation and related issues. However, I realized open space should not only serve evacuation purposes, it is also part of our daily life. As a result, I tried to add the scenarios of improving current living quality and mapped the findings together as final products. During this whole year, this project has taught me to think not only vertical approaches but always think about horizontal aspects while dealing with designs.

Analysis, Planning, and design

Due to my background as a landscape architect, I seldom deal with such big scale projects, and that was part of the reason I chose this topic. During the process, I have improved my skills of making bigger scale designs, zooming into the detail design smoothly, as well as the way to make the project more relevant on the different scales.

On top of this, because of this project, I have learned more about the whole porcess of spatial design, and am more able to consider about user's spetial experiences in space.

Final products

Finally, answering the questions my tutors asked me one year ago: "What do you want to learn in this year? What is the final result that you are expecting?" I remember my answers were: "I want to be able to use this year to explore more about my own city, and I want to learn how to use different medias to translate my ideas to the audiences."

Now, I really understand more about my cultures, histories, and also the problems that my city is facing; besides, I am now able to make videos in 2D and 3D interfaces to explain my ideas in more entertainment ways.

Comparing my qualities and abilities between now and a year ago I am very happy with my achievements. I really enjoyed the process and the results of this year!

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APPENDIX

1. HISTORICAL IMAGES/MAPS

1.1 Taipei Lake

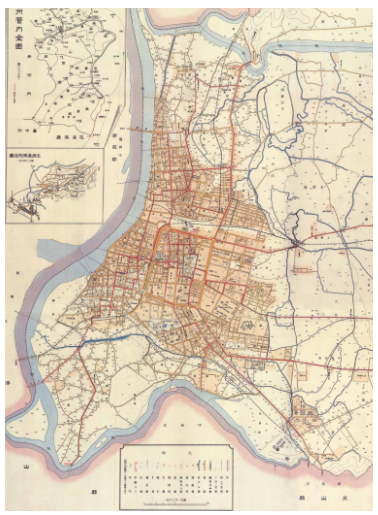
In the "雍正台灣輿圖" painted in 1723-1727, it can be seen that the Taipei Basin is immersed in water.

About this "disappearing Lake of Taipei", in 1697, Yonghe Yu, the aide of Fuzhou's perfect, wrote in "Bohai Journey (裨海紀遊)": "From the port of Danshui, in the front of the two mountains (now Guan-du), I entered the waterway. Suddenly, the view became wider, and an endless lake appeared." According to his book, a local guide told Yonghe Yu this big lake was made by the 1694 Kangxi earthquake.

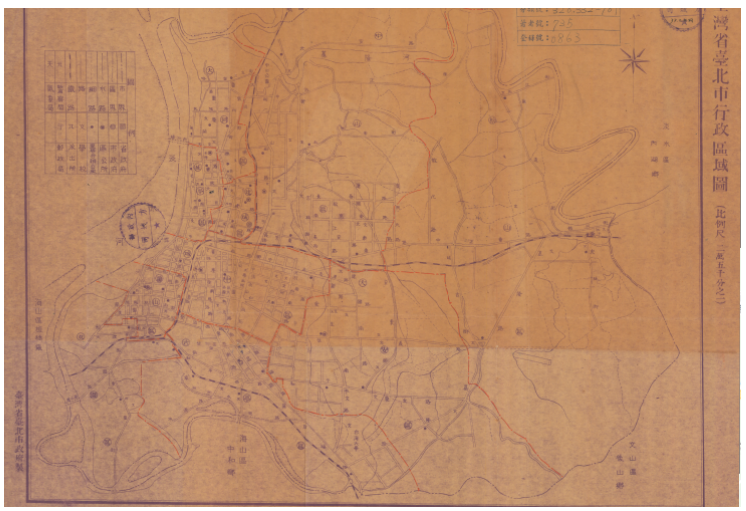
1.2 Historical Maps of Taipei City

1895

1932



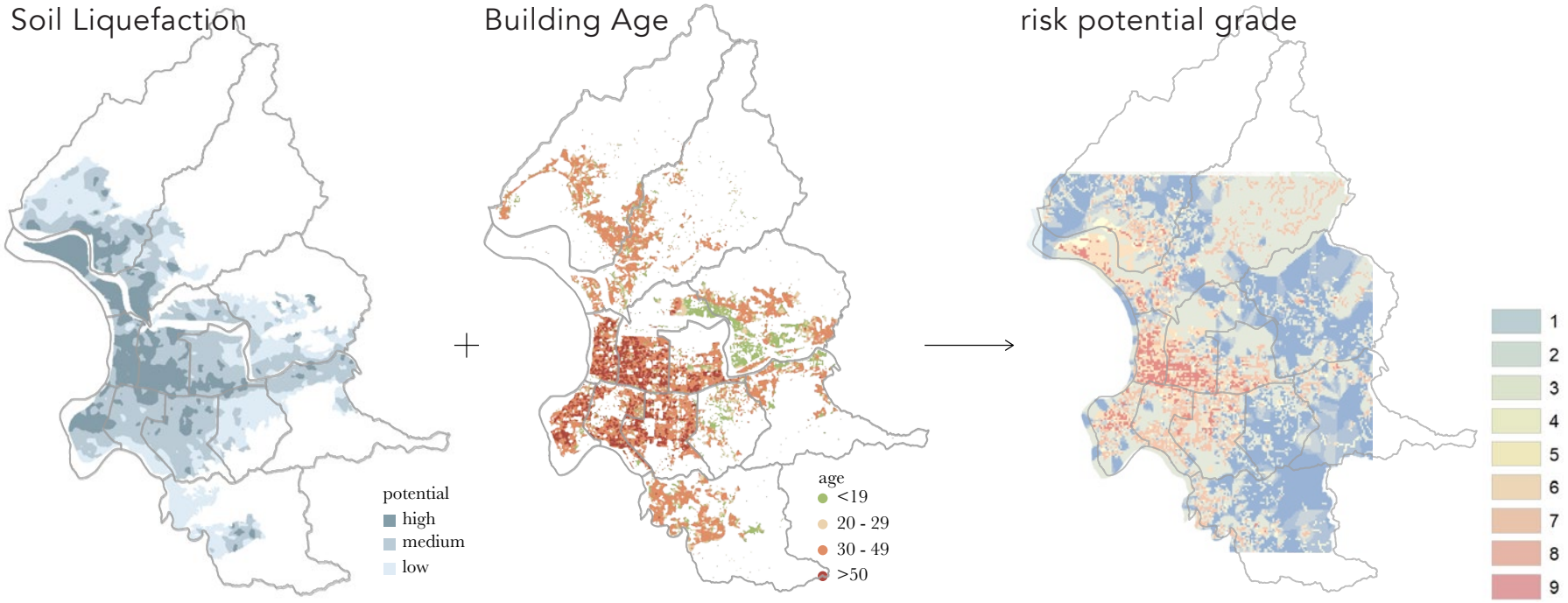
1948



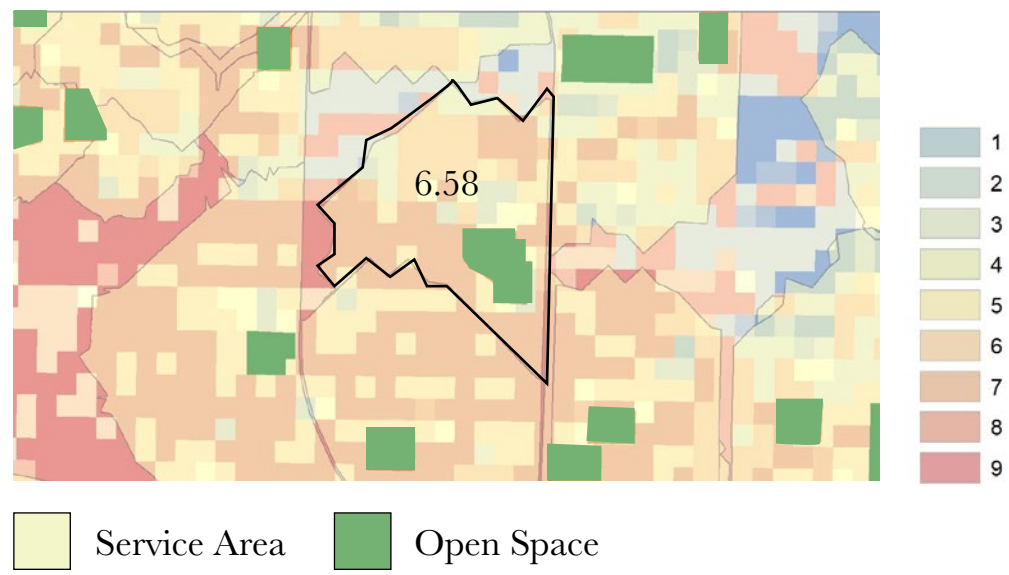
Map Archives of Taiwan. Retrieve from http://gissrv4.sinica.edu.tw/gis/twhgis/

2. Risk Potential Percentage

Since not all the people will need to evacuate, the population is based on the prediction percentages and applied to the risk potential percentage. In this case, take evacuation sites as an example, the prediction evacuation percentage in this stage is 10%-40% (Lin, 2007) if the risk potential is higher in the area, the evacuation percentage should be higher as well.



Zoom in



As a result, to demonstrate the calculation, the image on the left zooms in to one service area, and the steps of evacuation percentage are as followings:

firstly, by mapping the risk potential analyses (soil liquefaction and building age), the result map represents the risk potential and grades it from 1 to 9.

Secondly, calculate the average of risk potential grade by ArcGIS in the short-term refuge service area, in this case, the average is 6.58.

Last, calculate the evacuation percentage by the average risk potential:

[(6.58-1)/(9-1)]*(40-10)%+10%=30.925%