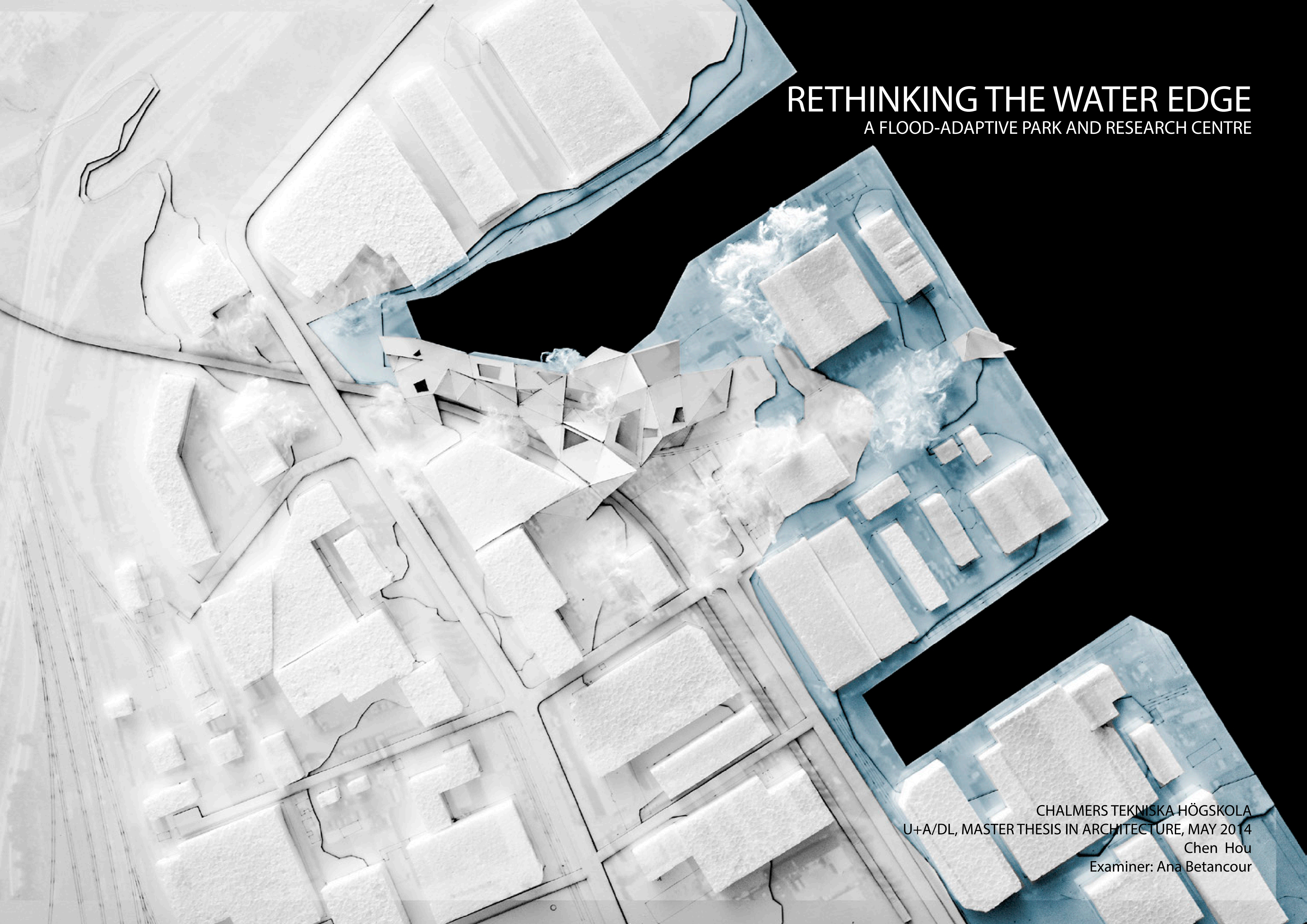


RETHINKING THE WATER EDGE

A FLOOD-ADAPTIVE PARK AND RESEARCH CENTRE

CHALMERS TEKNISKA HÖGSKOLA
U+A/DL, MASTER THESIS IN ARCHITECTURE, MAY 2014
Chen Hou
Examiner: Ana Betancour

ABSTRACT

Flooding is today a severe threat facing 360 million urban residents worldwide. The city of Gothenburg is already affected and threatened by flooding as a result of sea level rise and an increased number of extreme weather events. The main development areas of the city are located right in the high risk flooding zones along the riverbanks.

The traditional resistant flood strategies try to prevent the water from reaching urban areas by stopping it in various ways, such as protection walls and pumps. The Gothenburg municipality is investigating resistant flood strategies such as barriers across and along the river. These infrastructures have high failure risks and are very expensive.

In my thesis I explore some more adaptive methods trying to bring resilient flood strategies from urban scale to building scale, stimulating technological progress and improving public cognition and educational process about flooding at the same time.

The site for the proposal is Ringön, an industrial area on the north side of Gothenburg River. Based on the site analysis, I introduce 3 strategies:

1.Increased absorption of water by transforming impervious surfaces to natural ground cover such as parks, green roofs and storm water gardens.

2.Spatial optimizing of the river banks to be able to adapt to changing water levels.

3.Increased knowledge and technological innovation through a research park and building include public science equipment such as wave flume, wave basin, creatures lab, data collecting and flood houses testing.

The main idea of the proposal is optimizing the water edge space by a new type of building. The building has two surfaces, one dry-surface above the water level and one wet surface inviting flooding water to change its spatial configuration. The programme for the knowledge park and water research centre is stimulating technological innovation about climate change and spreading this knowledge to the public, a place where citizens can feel the flood, see the latest research, test their own ideas, read books and even rent a floodable house.

I
POINT OF DEPARTURE

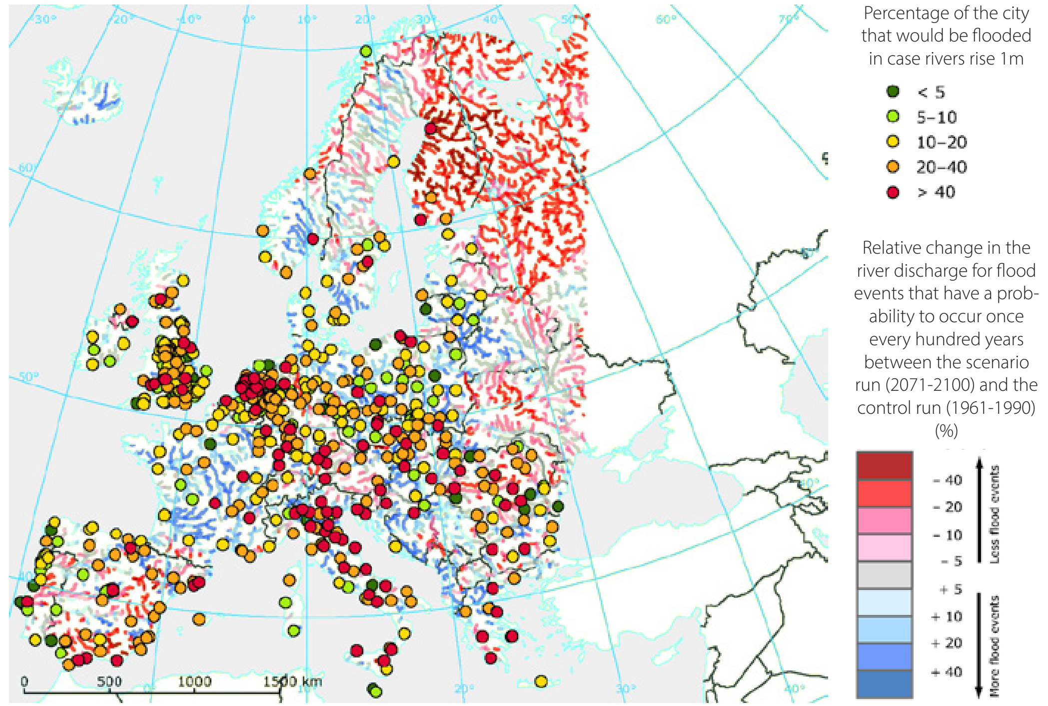
Memory of my hometown
Wuhan, 2007, China

After heavy rain, the city center flooded.
Truck and people wade through floodwaters in the campus of Huazhong University of Science and technology.

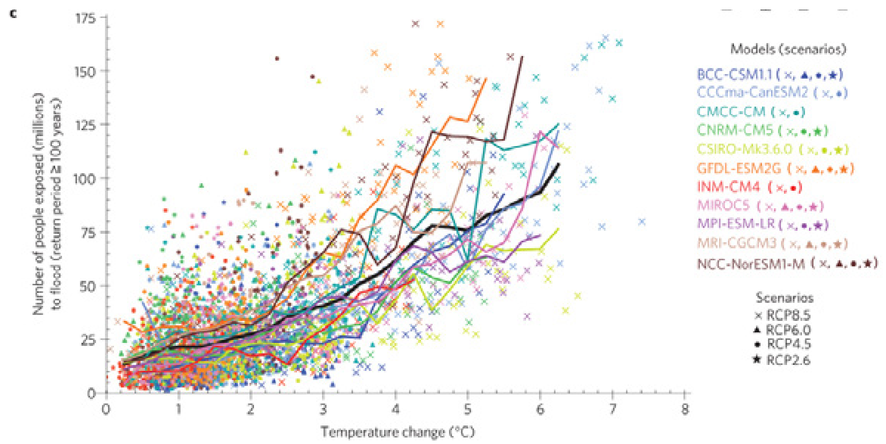
1.1 Global Flood Situation and Reason

Flooding is not a threat only in one country.
360 million urban residents are vulnerable to flooding and storm surges.
15 out of the 20 megacities are at risk afrom rising sea levels and coastal surges.

ref: http://www.nature.com/nclimate/journal/v3/n9/fig_tab/nclimate19011_F3.html[ ]
ref: http://urbanlabglobalcities.blogspot.se/2012_08_01_archive.html



European flood city map



Temperature change & number of people exposed to flood

Gothenburg

Gothenburg is already affected by flooding.

photos ref: Stora översvämningar i Göteborg. sverigesradio.se
Översvämning Nordsta. cherrycheek.blogspot.se

1.2 Gothenburg Challenge

development areas
are located right
in the high risk flooding zones
along the riverbanks.

BACKAPLAN
SIZE: 900000 ㎡
DEVELOPMENT RATE: 700000 ㎡

FRIHANMEN
SIZE: 500000 ㎡
DEVELOPMENT RATE: 500000 ㎡

NORRA ALVTRANDEN
SIZE: 1400000 ㎡
DEVELOPMENT RATE: 500000 ㎡

Reason 1
Sea Level Rise

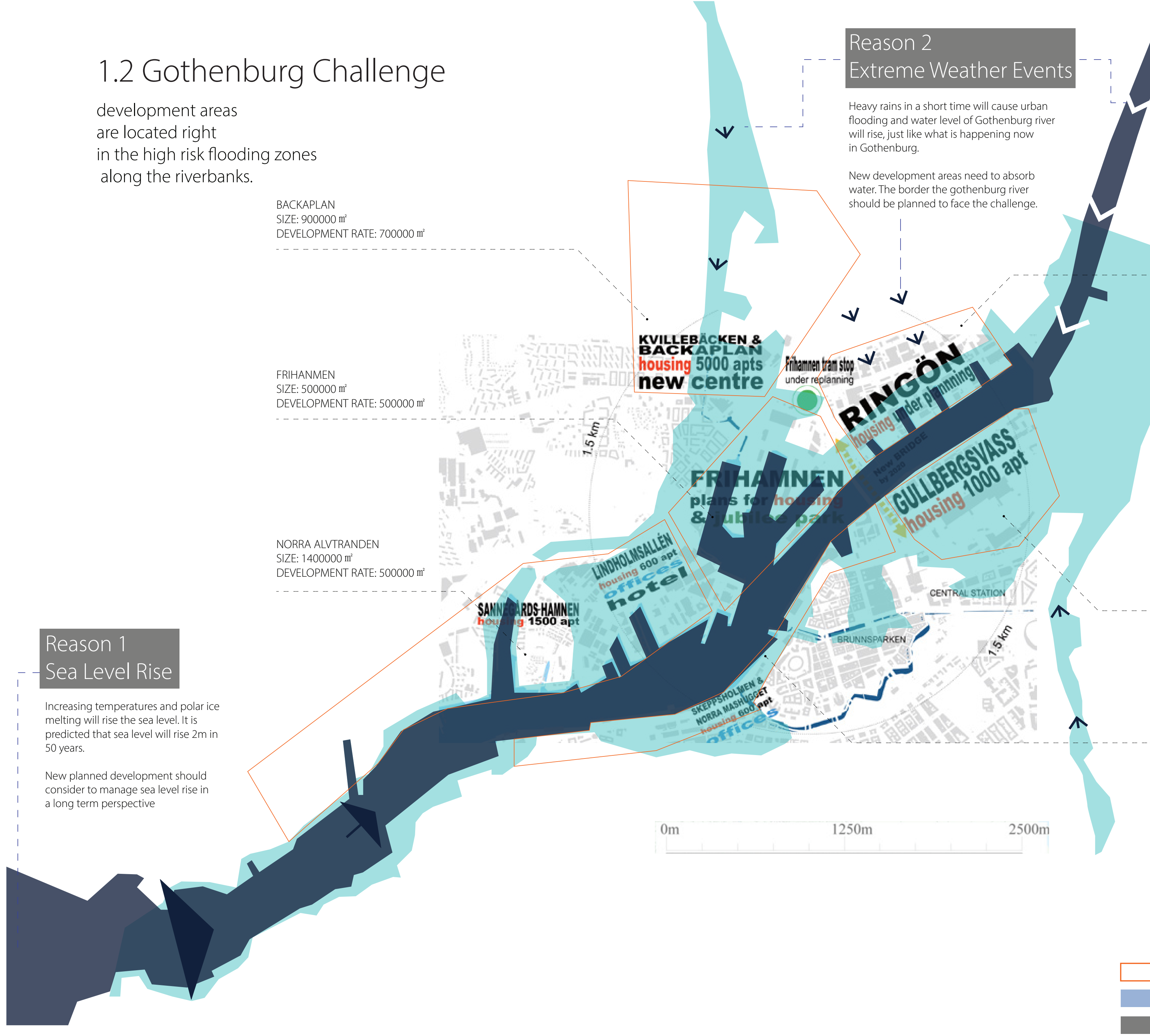
Increasing temperatures and polar ice melting will rise the sea level. It is predicted that sea level will rise 2m in 50 years.

New planned development should consider to manage sea level rise in a long term perspective

Reason 2
Extreme Weather Events

Heavy rains in a short time will cause urban flooding and water level of Gothenburg river will rise, just like what is happening now in Gothenburg.

New development areas need to absorb water. The border the gothenburg river should be planned to face the challenge.



RINGÖN
SIZE: 700000 ㎡
DEVELOPMENT RATE: 300000 ㎡

GULLBERGSVASS
SIZE: 800000 ㎡
DEVELOPMENT RATE: 800000 ㎡

SODRA ALVSTRANDEN
SIZE: 500000 ㎡
DEVELOPMENT RATE: 1500000 ㎡

Development Plans
Flood Risk Zones +1.7m
Reasons of Flood

ref: Gothenburg Stad

1.3 Methods

RESISTANCE METHODS: BARRIERS & HIGHER DEFENSES

Barriers

Maeslantkering, Netherlands

Bewdley Flood Barrier, UK

Cases:
Maeslantkering in Netherlands and Thames Barrier in UK is the world largest flood control structures. Bewdley Flood Barrier is a typical river side barrier to protect the city from flooding.

Problems:
Expensive and Barriers Broken Risks

Water spills over a levee along the Inner Harbor Navigational Canal in the aftermath of Hurricane Katrina on August 30, 2005, in New Orleans. After levees and flood walls protecting New Orleans failed, 80 percent of the city was underwater.

The traditional resistant flood methods

ref:http://en.wikipedia.org/wiki/maeslantkering

These infrastructures have high failure risks and are very expensive.

ref: http://en.wikipedia.org/wiki/Hurricane_preparedness_for_New_Orleans
http://soundwaves.usgs.gov/2006/01/

AMPHIBIOUS HOUSES AND FLOATING HOUSES


Aquavista ,Almere


Steigereiland, Ijurg

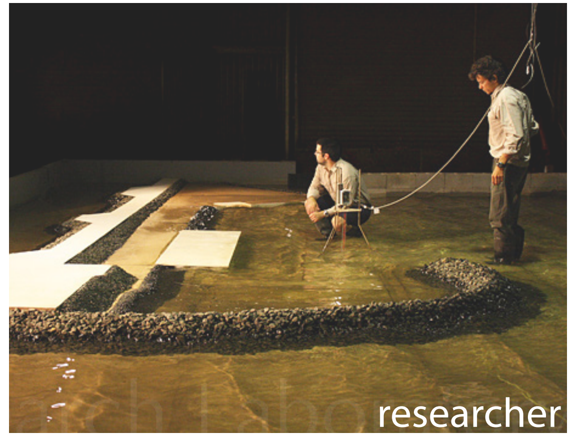
FLOOD BUFFER ZONES


Rhone, Lyon


Nahe, Bad Kreuznach

RESILIENCE METHODS

In my thesis I explore more adaptive methods
i try to bring resilient flood strategies from urban scale to building scale.
stimulate technological progress
improve public awareness

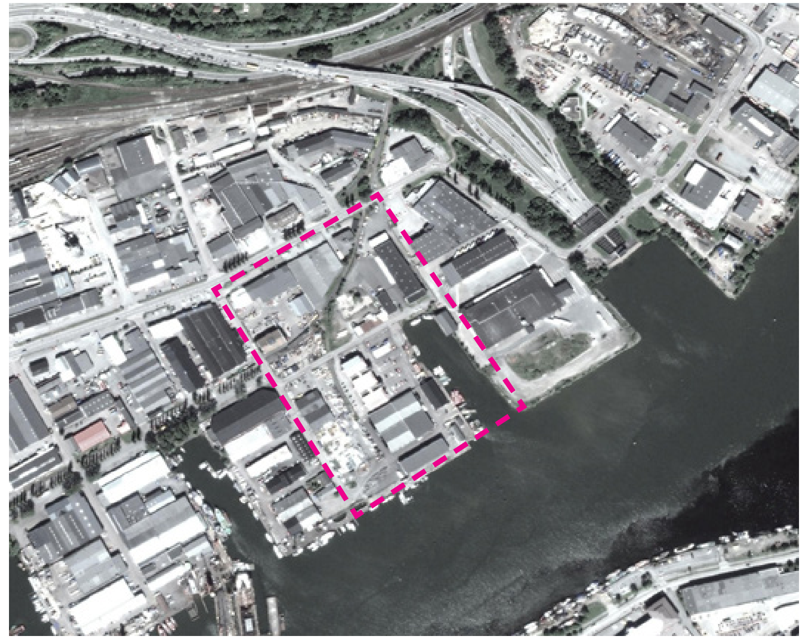
	CITY	SOCIETY
SMALL	 building	 researcher
LARGE	 region	 public

ref: http://www.wrl.unsw.edu.au/site/expertise/coastal-engineering/
http://locallygrownnorthfield.org/post/tag/flood-preparedness
http://www.rebuildbydesign.org/project/flood-adaptive-design-on-the-hudson-peninsula-jersey-cityhoboken/
http://inhabitat.com/see-the-four-finalists-selected-to-design-storm-resistant-housing-in-the-rockaways/

II
SITE, ISSUES & STRATEGIES

2.1 Ringön: Location & Analysis

The site for the proposal is Ringon, an industrial area on the north side of Gothenburg River.

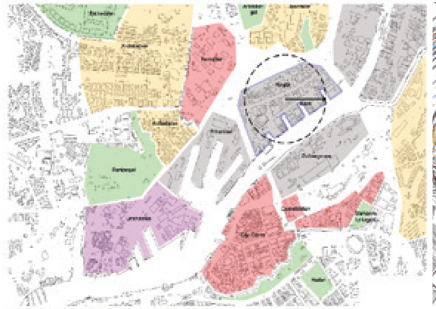


2.2 Site Analysis

Streets Train tracks

Bus line Tram line

The circulation system for public transportation and pedestrian is insufficient. The site has its own well-designed street stucture but it is not well connected with surround urban areas. Only bus line 47 has stops on the site. No tram lines



Research/Academic Industry Site
Residence Complex/Commerce Green space

area with a lot of noise

industrial area with a high pollution

Since the site is an area of industries, there is a lot of pollution caused by production in some parts. Around Ringagatan, the biggest and noisiest street in this area which passes the whole site, there situated a lot of commercial agencies while the southern part of the site is mostly settled by industrial enterprises which often do not allow access for pedestrian. Ringon provides a lot of jobs

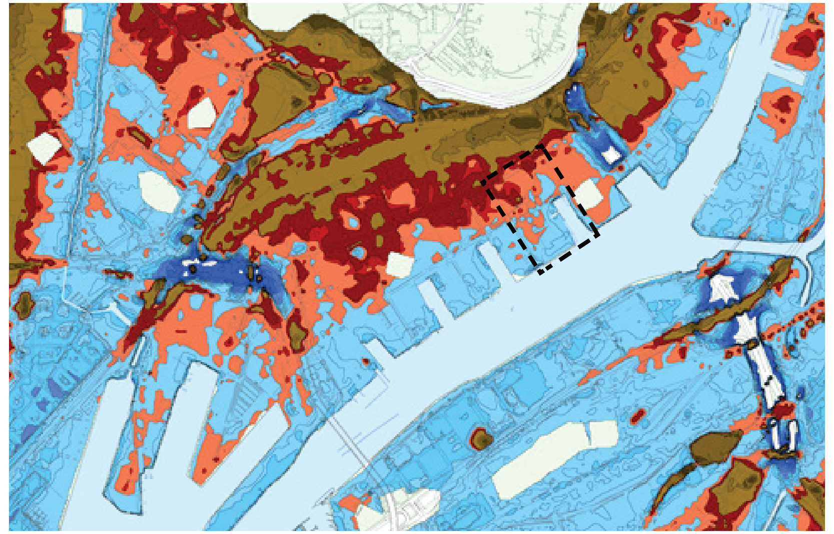
2.3 Site Issues & Strategies

Based on the analysis, I summerize 3 issues of the site.
And I introduce 3 strategies .

ISSUES	STRATEGIES
ISSUE 1 BORDER CONDITIONS	STRATEGY 1 RIVER BANK SPATIAL OPTIMIZING
ISSUE 2 LAND CONDITIONS	STRATEGY 2 ABSORB WATER
ISSUE 3 PROGRAMMES	STRATEGY 3 KNOWLEDGE & TECHNOLOGY INNOVATION.

ISSUE 1

BORDER CONDITIONS



Site Flooding Map

Preliminära marknivåer
+ höjd (Göteborgs höjdsystem)

- 8.0 - 8.5
- 8.5 - 9
- 9.0 - 9.5
- 9.5 - 10.0
- 10.0 - 10.5
- 10.5 - 11
- 11.0 - 11.5
- 11.5 - 11.8
- 11.8 - 12.3
- 12.3 - 12.7
- 12.7 - 12.8
- 12.8 - 13.2
- 13.2 - 14.5
- 14.5 - 15.0
- 15.0 - 15.5
- 15.5 - 16.0

Site Ground level +11.1 - +13.2m

Averages:
south +11.8 m
north +13.0 m

Normal water level in Göta älv +10.1 m
Current highest extreme water level +11.8 m
Extreme flood scenario +12.3 m

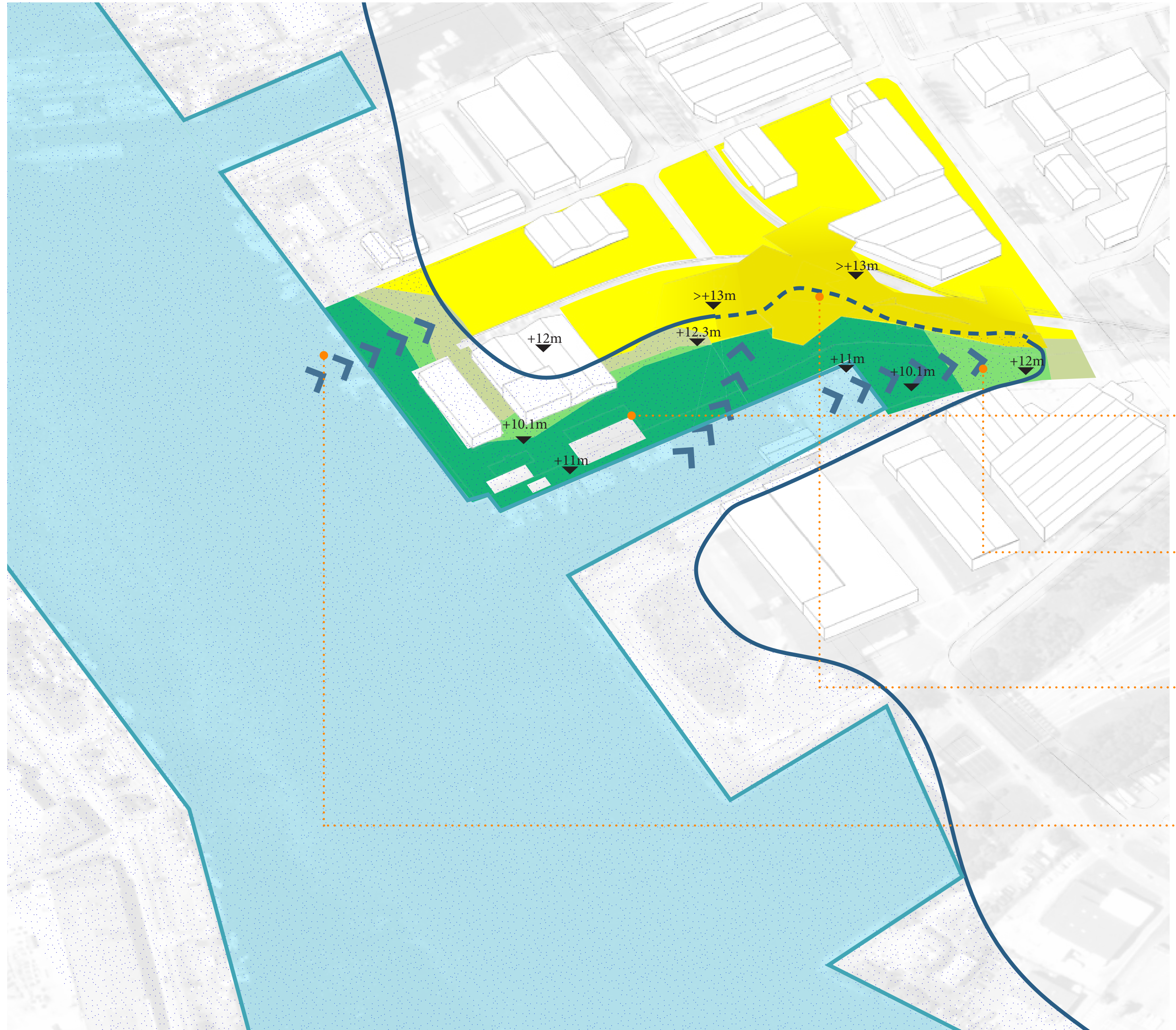
Current Risk Plan - Barriers Alongside

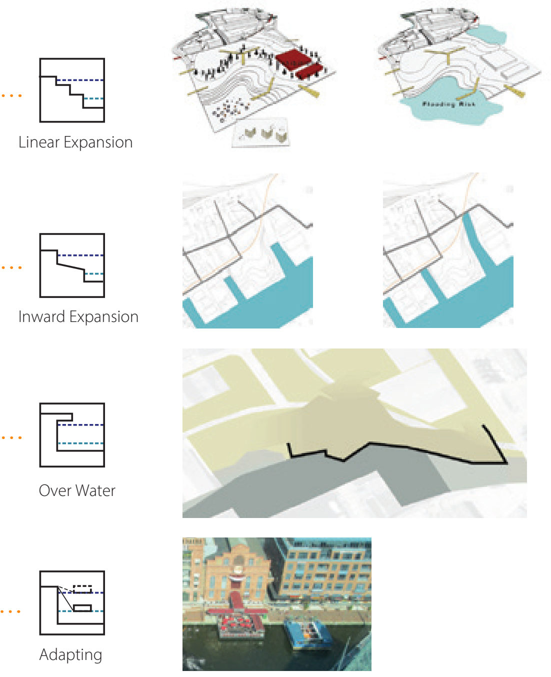
The strategy of building up barriers along the Gothenburg River banks is investigated by the Gothenburg municiplaity. This kind of resistance method has problems. It will block the access of crossing the river and make the north part and south part of the city seperated. It will block the view of water. And it has the risk of infrastructure failure which would cause disaster.

STRATEGY 1

River Bank Spatial Optimizing

The river banks can be able to adapt to changing water levels





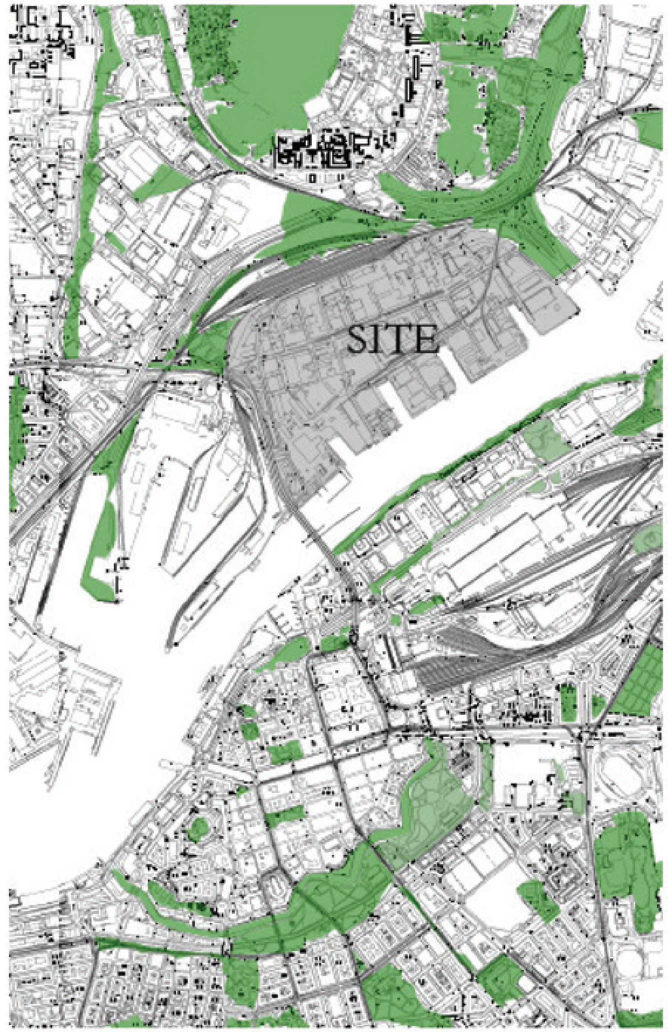
Ref: Anne Loes Nillesen, Jeroen Singelenberg (2011). Amphibious Housing in the Netherlands: Architecture and Urbanism on the Water. Nai010 publishers

Matin Prominski (2012). River.Space.Design. Birkhaeuser

ISSUE 2
LAND CONDITIONS

History Map And Geology

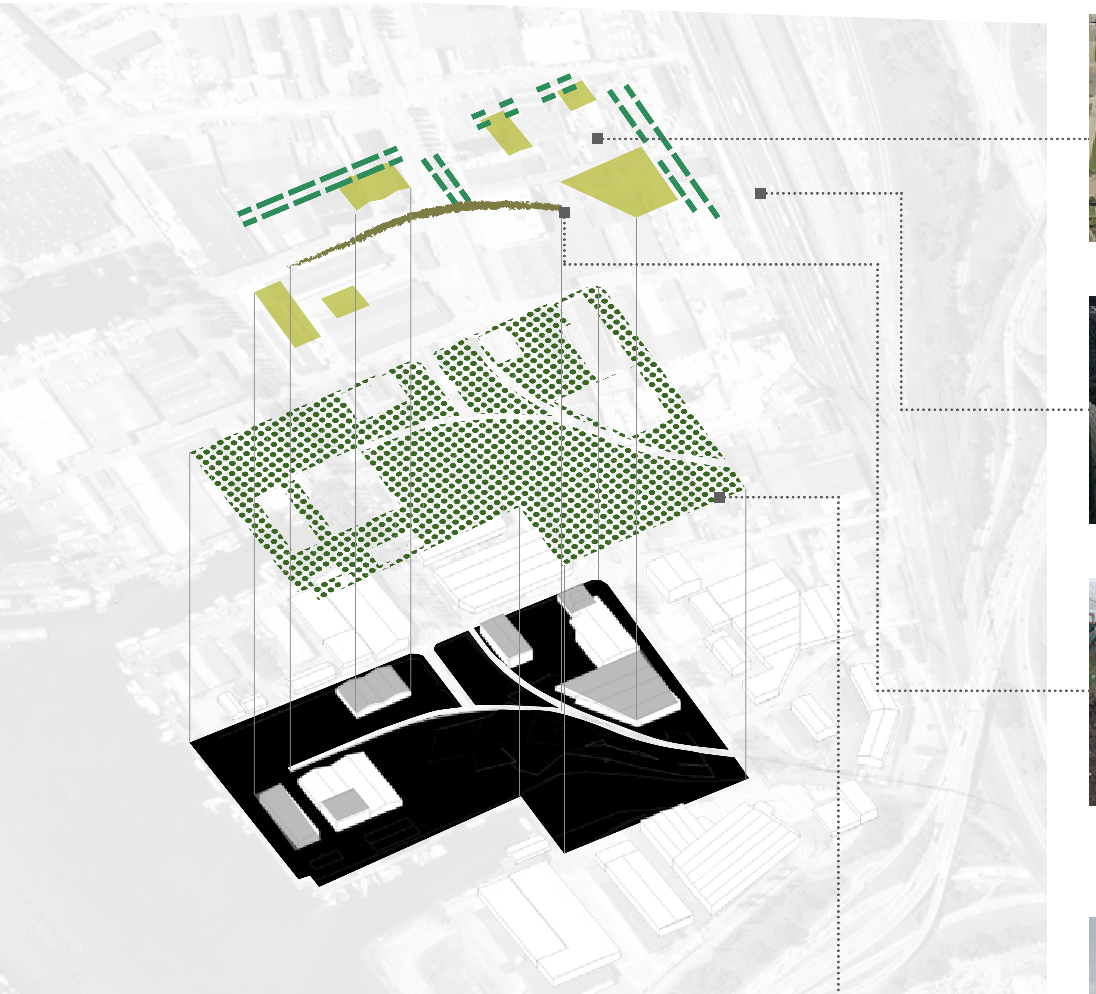
Most of the urban land along the river in Gothenburg are hardmade impervious surfaces. The reason is historical. At the beginning the brown areas are river but later they became infilled land as the city growing. Problems: When precipitation reaches paved areas it runs into the storm water system which can get overloaded. The overloaded city water and high river water levels can lead to flooding together.



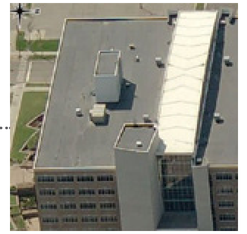
Natual land can absorb water. However, currently there is very few green space in this area and a lot of artificial barries like fences cut the site.

STRATEGY 2
Absorb Water

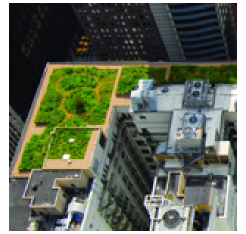
Increasd absorption of water by transforming impervious surfaces to natural ground cover such as parks, green roofs and storm water gardens



ref:
Stormwater management for clean rivers: How to manage storm water
Environmental services city of Portland
Massachusetts Low Impact Development Toolkit: Green Roofs
Metropolitan area planning council, Arc Innovation
How to Install a Greenwall – Part 1 – An Overview to Building a Greenwall Inside Your Home.Urenocanada.wordpress.com
http://www.greenfab-media.com/wp-content/uploads/2008/04/green-street.jpg
http://www.portlandoregon.gov/bes/article/188636
http://www.mapc.org/sites/default/files/LID_Fact_Sheet_-_Green_Roofs.pdf
http://urenocanada.wordpress.com



Existing Buildings' Roof



Green Roof

Reduce total runoff volume through rainwater storage and evapotranspiration.
Reduce heating and cooling costs through roof insulation.
Extend roof life.

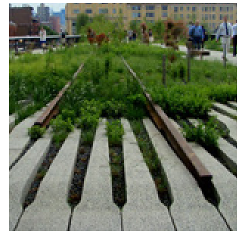
Sidewalk

When rain falls, it washes over driveways and wash dirt, oil and chemical into rivers and groundwater

Sidewalk Rain Garden

A rain garden can collect rainwater, filter pollutains, and helps reduce flooding.

Abandoned Railway

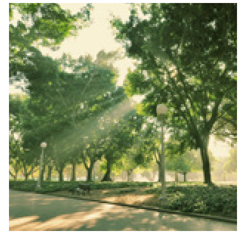


Railway Landscape

Tranform abandoned industrial elements to landscape which can absort rainwater and provide habitat for creatures.

Abandoned Storage Lands

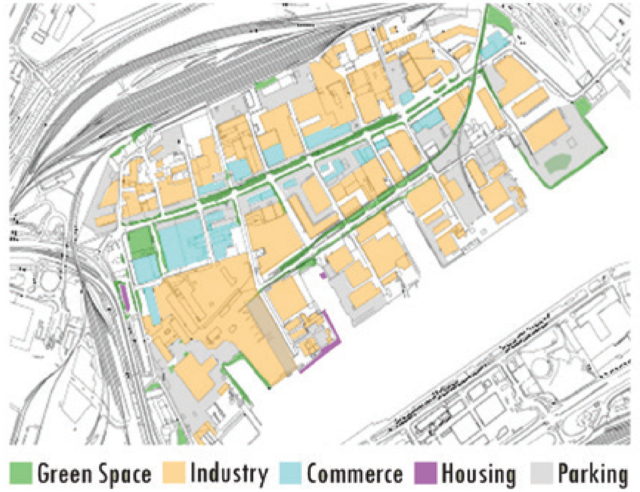
Most of the empty lands are hardmade impervious surfaces which only have 10% shallow infiltration and 5% deep infiltration (runoff 55%)



Green Park

By tranforming impervious surfaces to green park with natural ground cover, the shallow and deep infiltration can be increased to 25% and 25% (runoff 10%).

ISSUE 3
PROGRAMMES



Current Programmes Of The Site
Tranforming Period

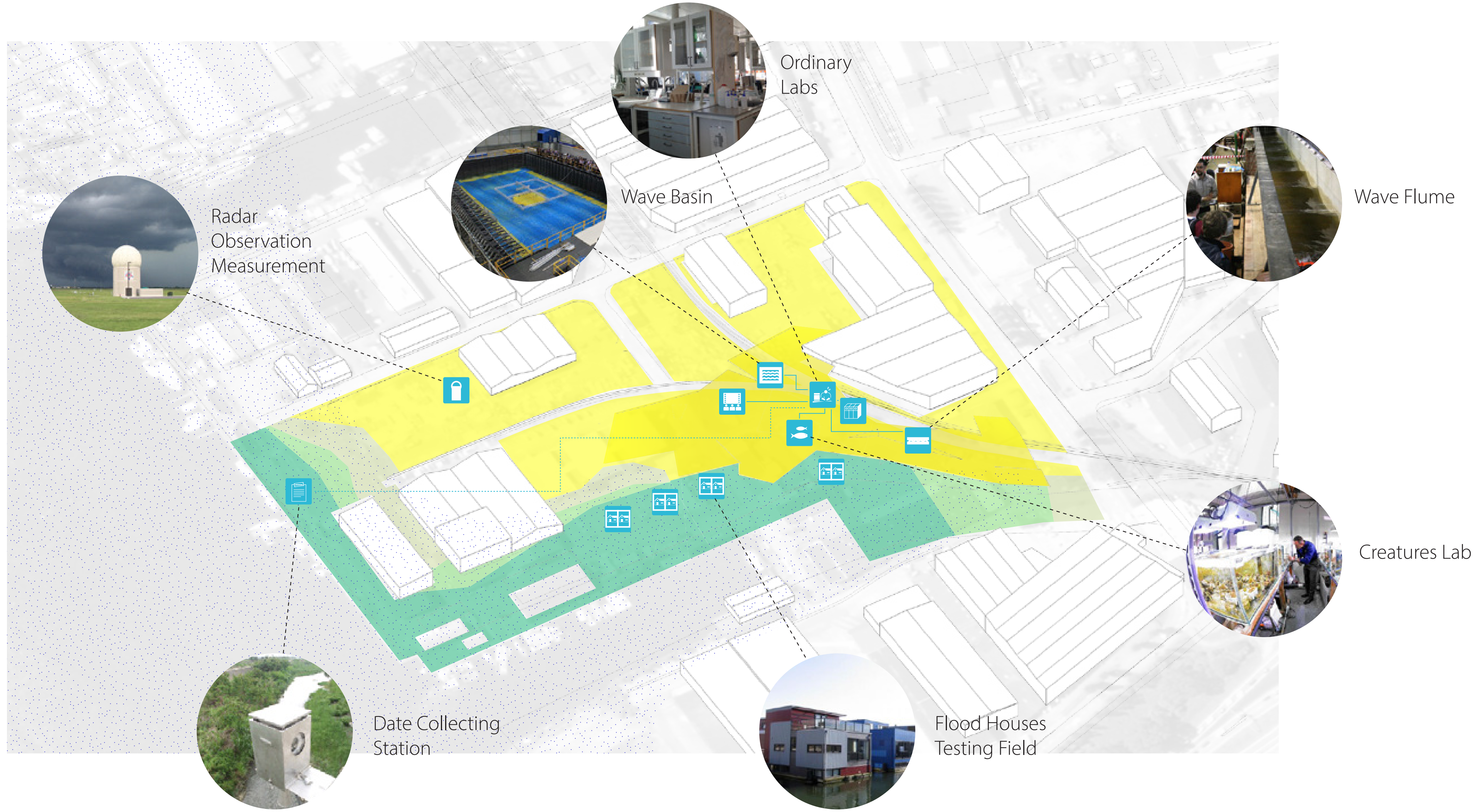
About 800 companies settled in an area of more than 200 hm2 and they are specialised on different branches such as health care, pet care, recycling and gastronomy.


Marine Companies
on the site

Harbour Industry
Ship Technology
Swedish Technology Traditions

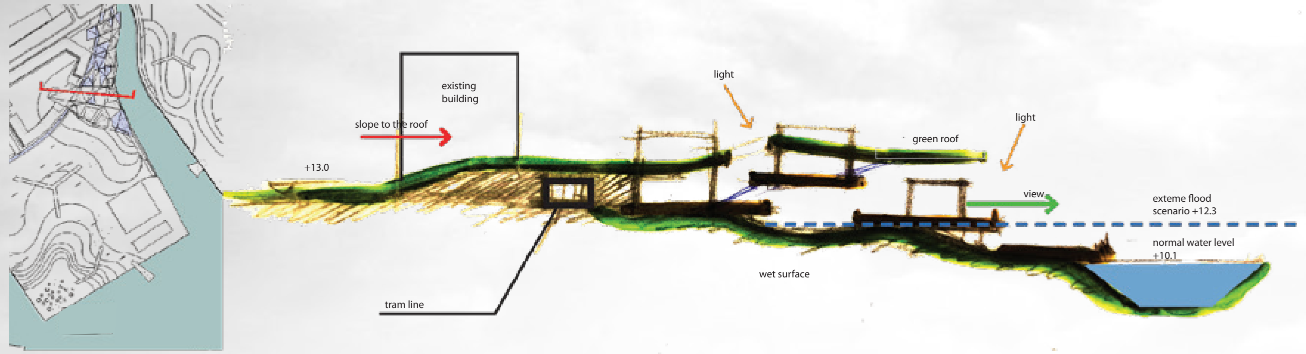
STRATEGY 3
Knowledge & Technology Innovation.

Increased knowledge and technological innovation through
a research park and research building include science equipment.



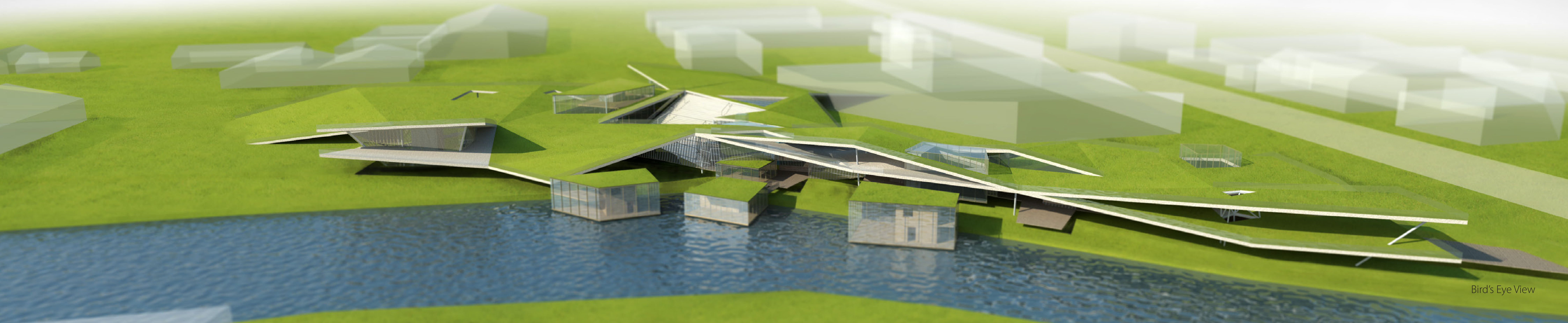
III
PROPOSAL

3.1 Concept

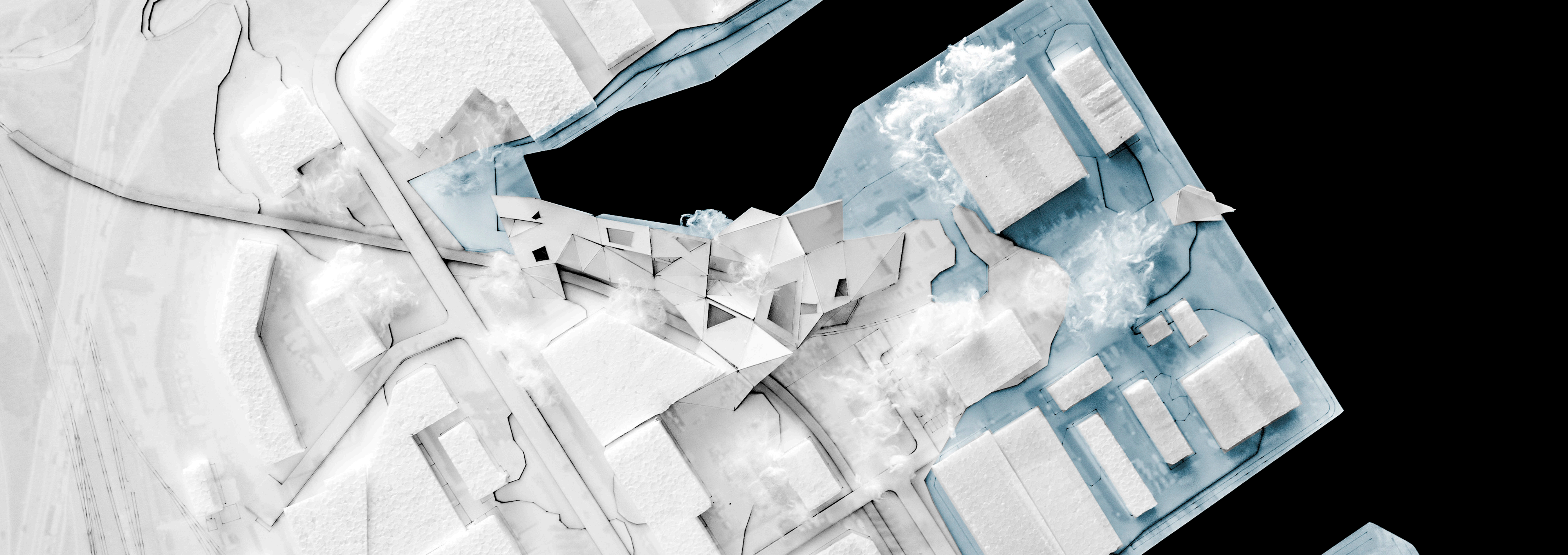


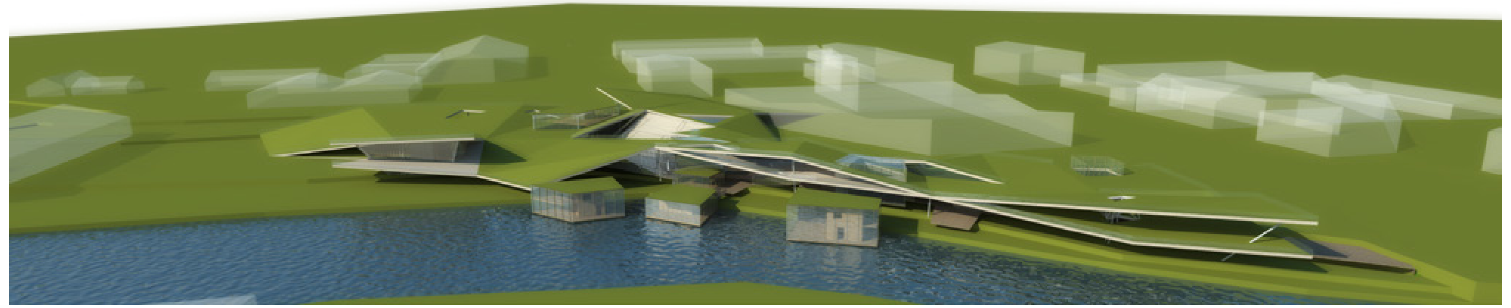
Conceptual Section

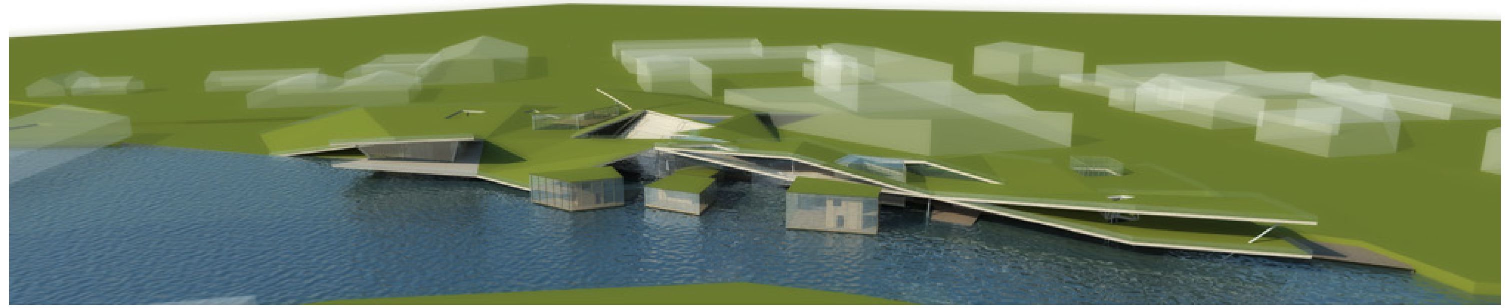
introduce a new type of building
on the water edge space.
one dry-surface above the water level
and one wet surface inviting flooding water to
change its spatial configuration.

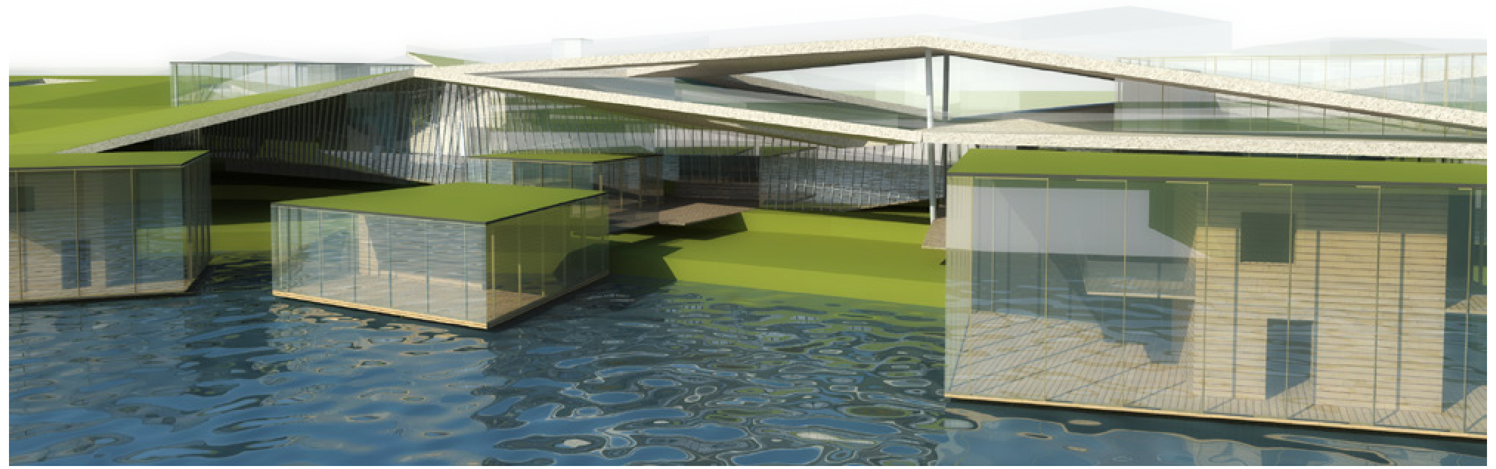


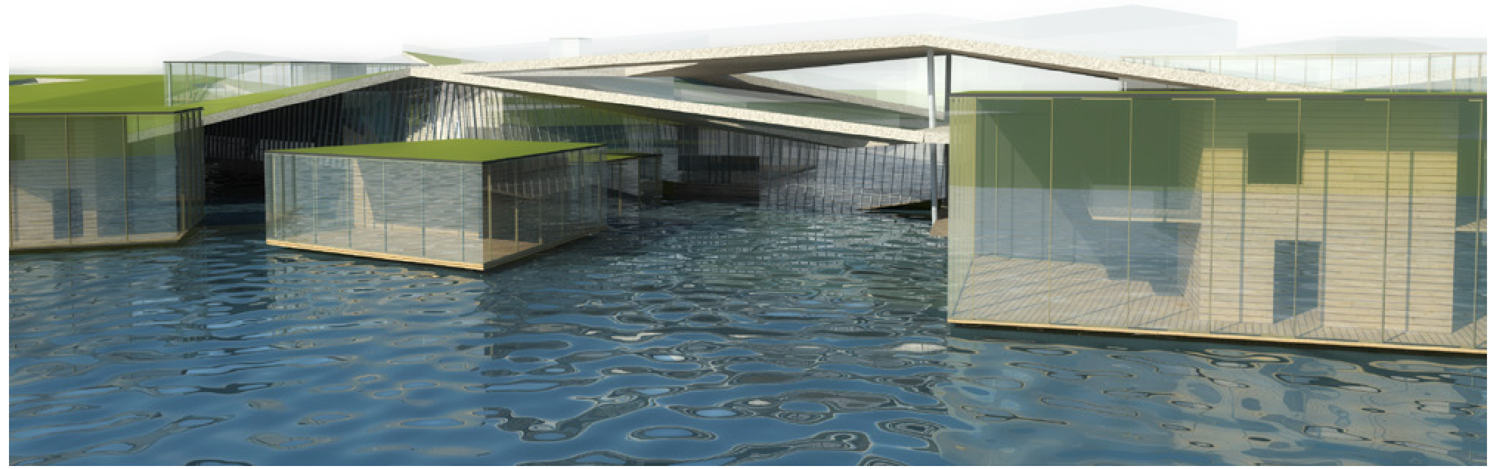
Bird's Eye View



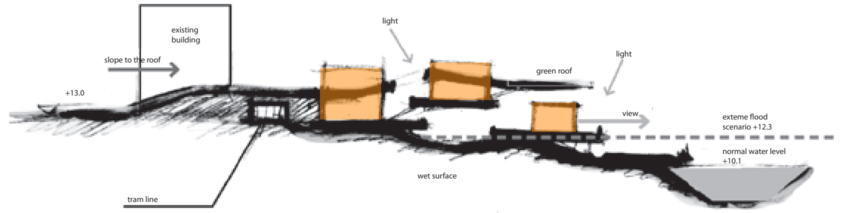


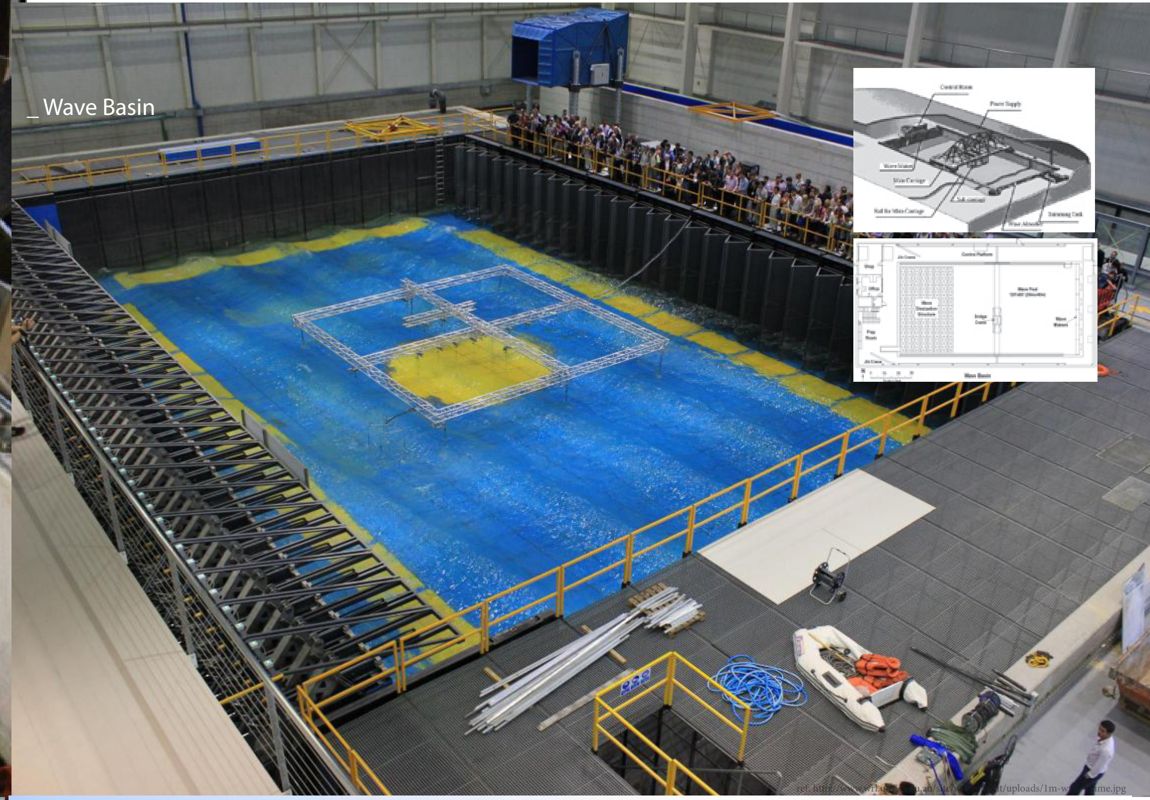


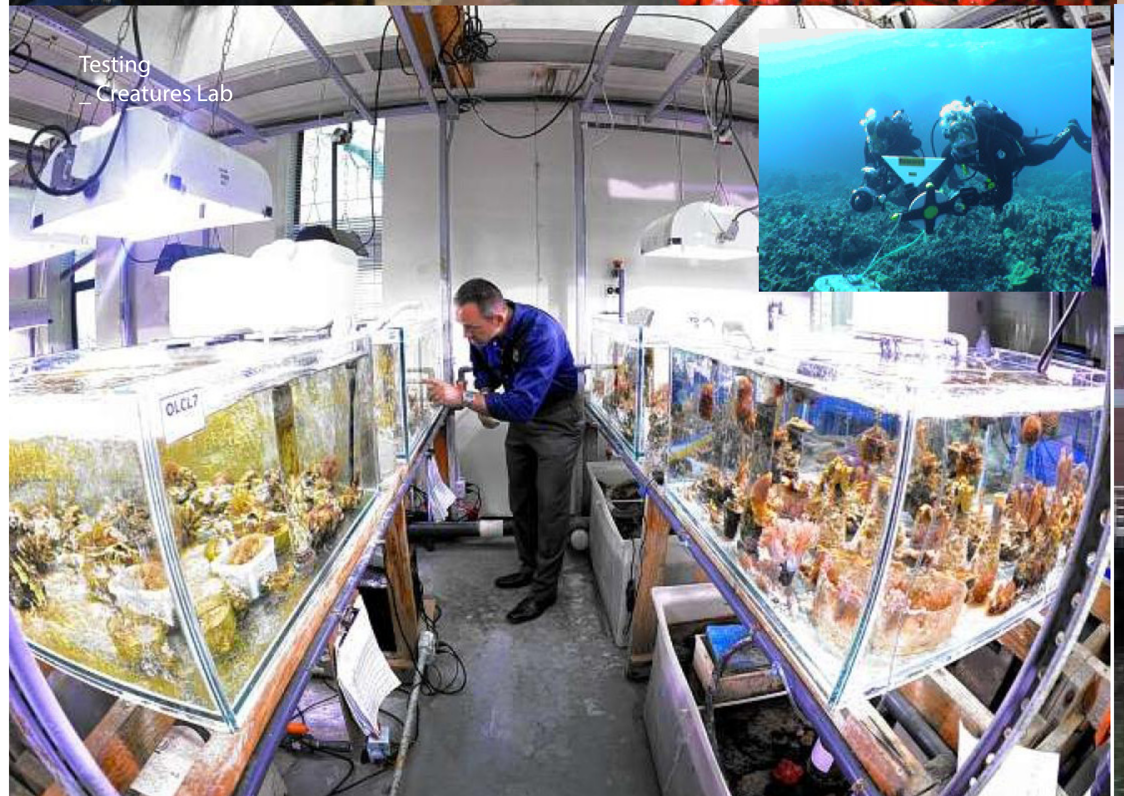




3.2 Programmes





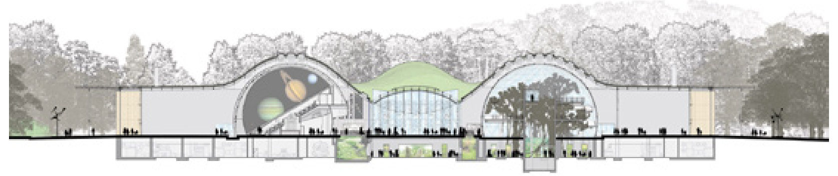


ref: http://www.wrl.unsw.edu.au/site/about_us/downloads/
http://www.wrl.unsw.edu.au/site/wp-content/uploads/wave-basin.pdf
Flap ocean wave generators www.edesign.co.uk/product
Wave generators www.edesign.co.uk/waves



What does a research building look like?
Cold, isolated in the city.
Fences. Public is not allowed to enter it.



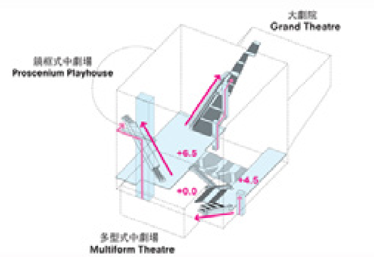


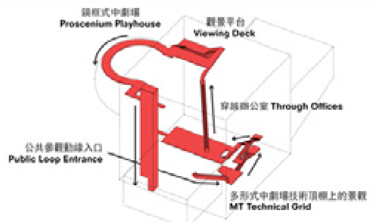
California Academy of Sciences

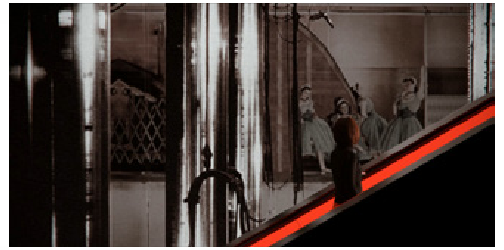
2008
Renzo Piano

PUBLIC - RESEARCHER

The California Academy of Sciences is unique amongst natural history museums in its dedication to combining research and education under one roof.





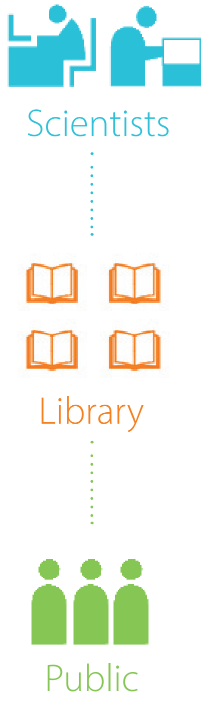



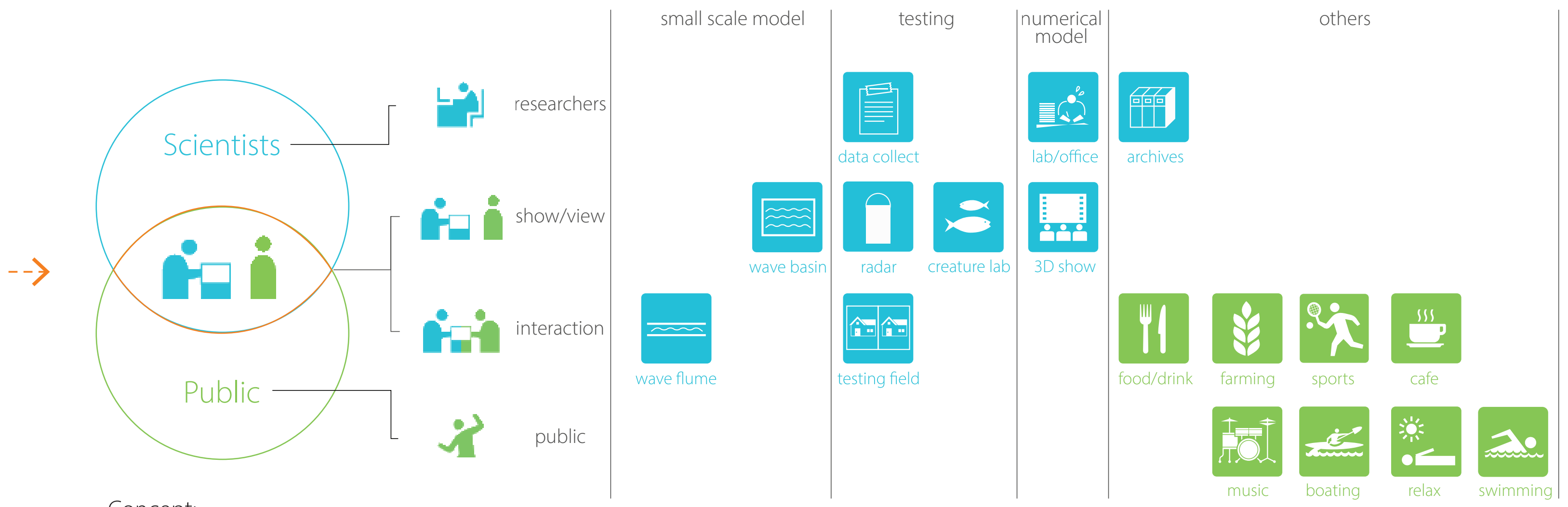
Taipei Performing Arts Centre

2015
OMA

PUBLIC-BACKSTAGE

"The general public-even those without a theatre ticket-are also encouraged to enter TPAC. The Public Loop is trajectory through the theatre infrastructure and spaces of production, typically hidden, but equally impressive and choreographed as the "visible" performance. The Public Loop not only enables the audience to experience theatre production more fully, but also allows the theatre to engage a broader public."





Concept:
A Water Library Trying To Merge The Profession And Public

Traditional Way of climate change knowledge spread

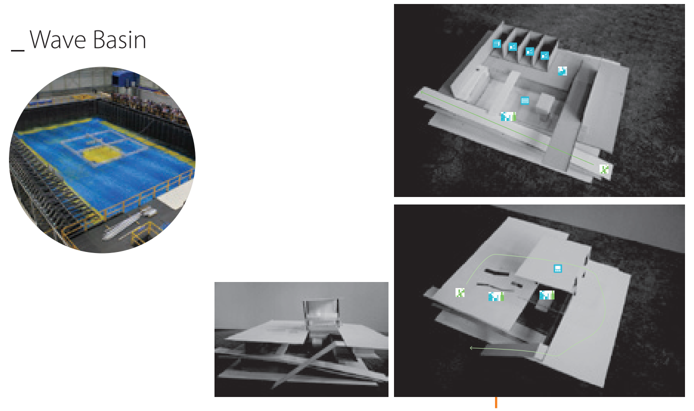
Problumes:
1.inefficiency: not the latest knowledge
2.one-way: no interaction in between

stimulate technological innovation about climate change

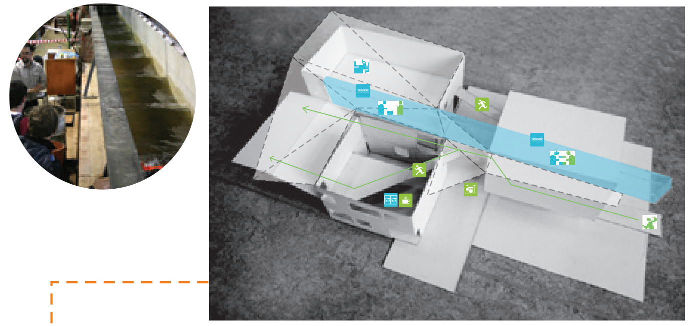
and spread this knowledge to the public

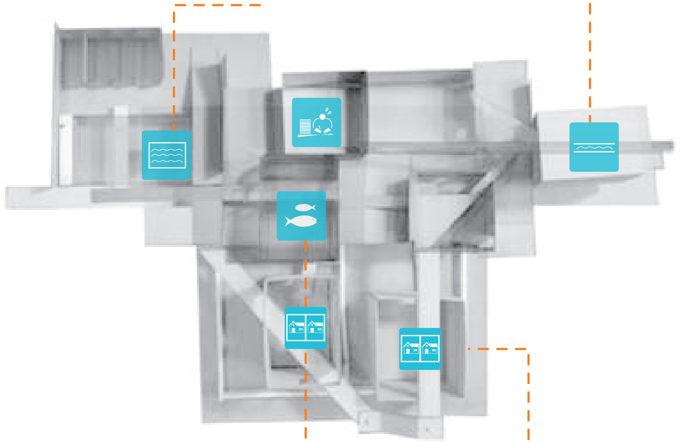
a place where citizens can feel the flood, see the latest research, test their own ideas, read books and even rent a floodable house.

_ Wave Basin

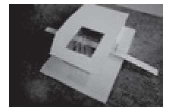


_ Wave Flume

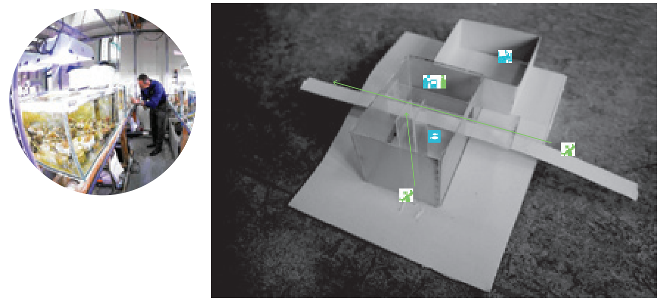




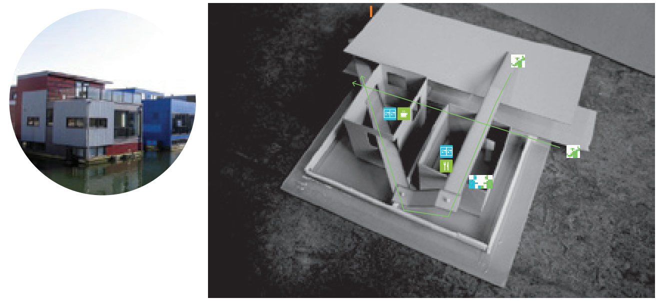
Space Research
Considering the Relations
between Research
and Public Programmes



_ Creatures Lab & Aquarium

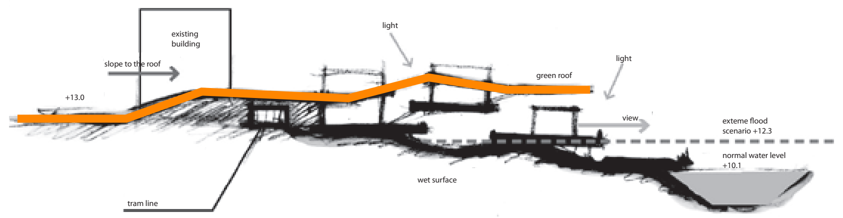


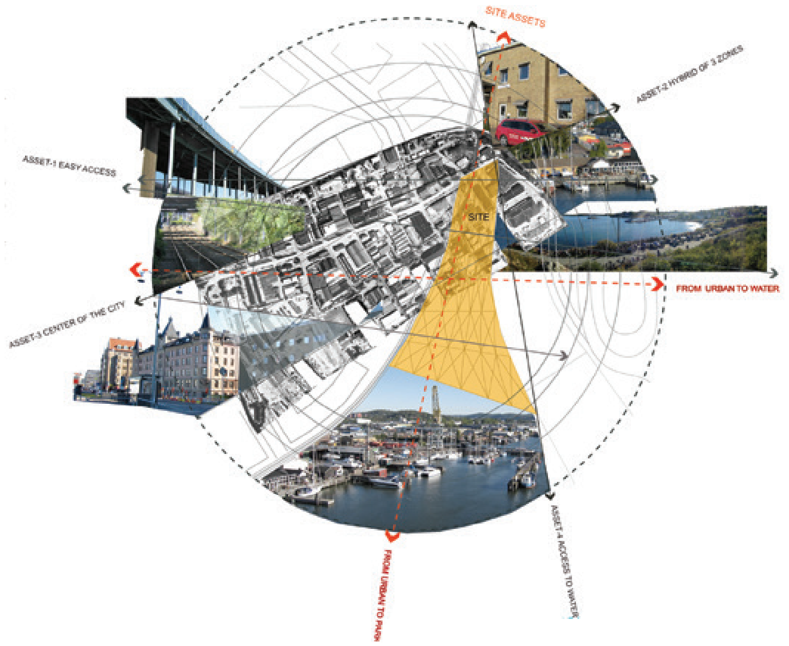
_ Flooding Houses Testing Field



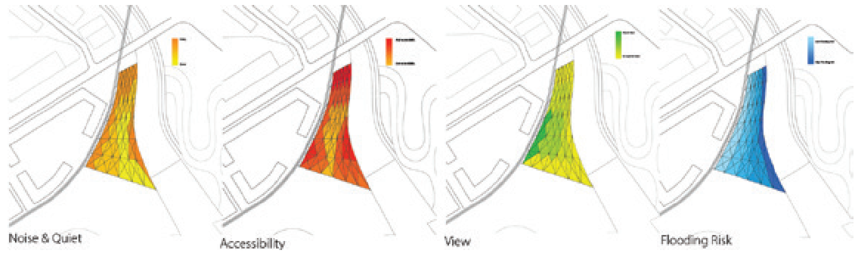
Research Model:
Relations between
New Programmes
on the Original Site

3.3 Structure

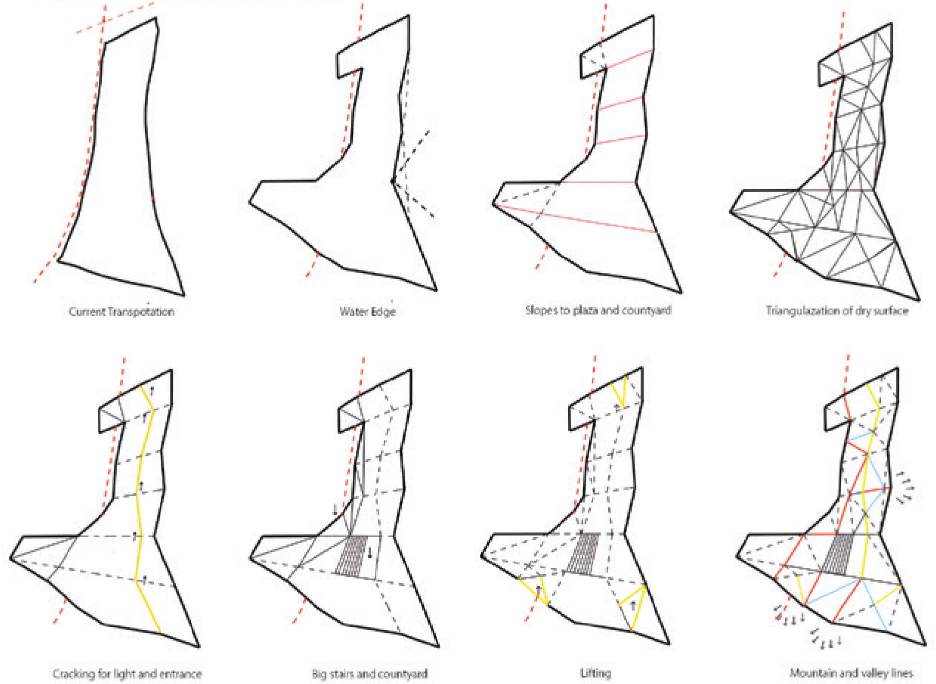




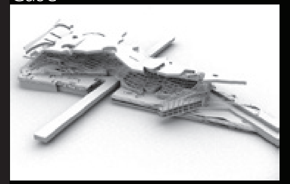
Folding Based on the Current Conditions



Folding actions

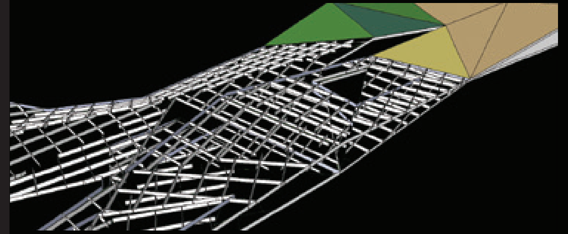


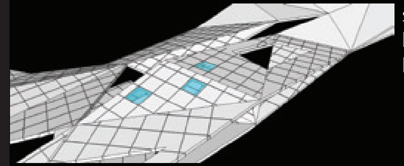
Case



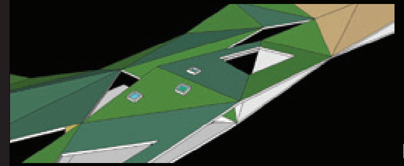
Giant Interactive Group Corporate Headquarters by Morphosis

Research Model





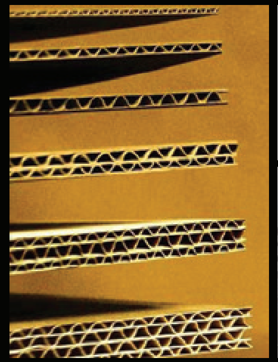
steel structure as bones inside each layer

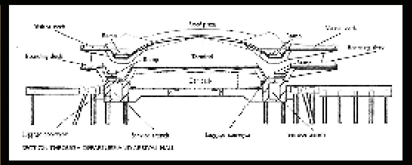


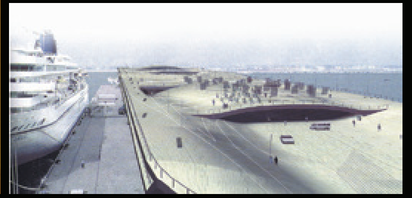
Roof windows

Steel Structure inside each layer

Case



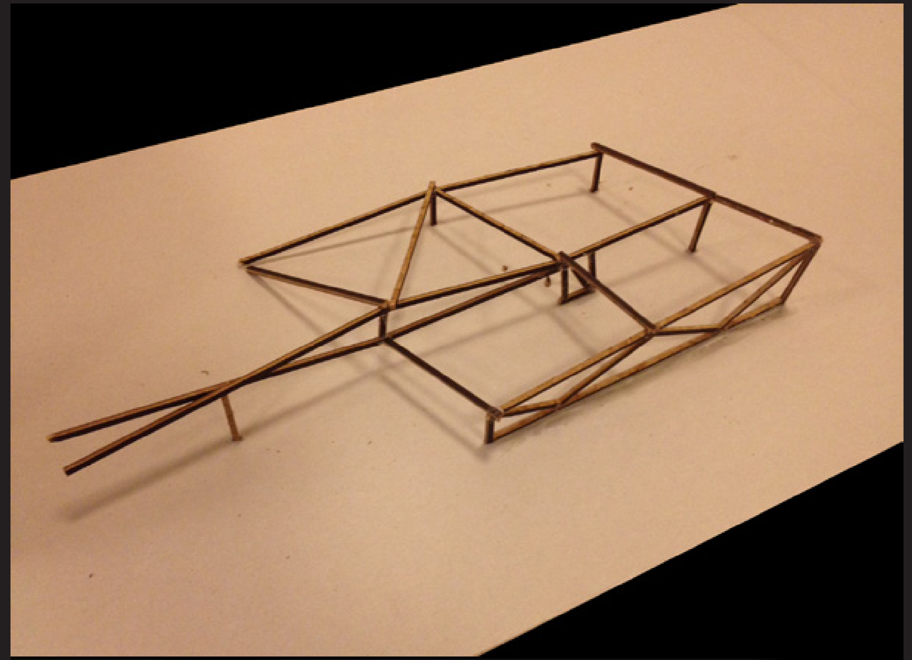


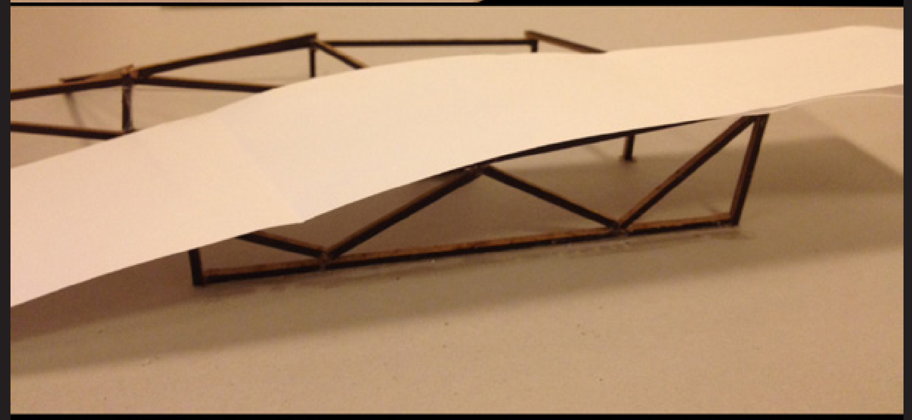


Model: Multi layers and Transmission of Force

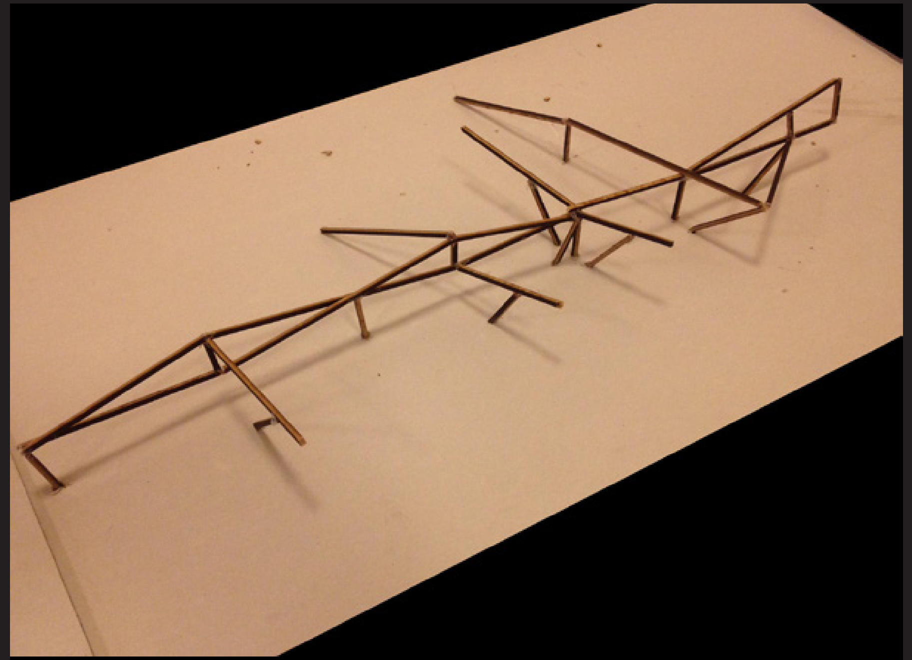
Multi-layer Surface as a Whole Structure

Yokohama terminal
'It transmit thr force to the foundation through the winding floor connecting upper and lower stories without counting the converntional column and girder system.'



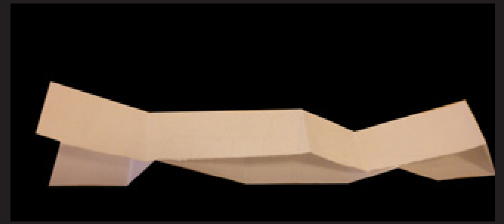


Skeleton Model 1 X



Skeleton Model 2 √

Pillars and beams support the surface. In Model 1, view from inside the building is blocked by the truss. Model 2 tries to optimize the openness of the water side.



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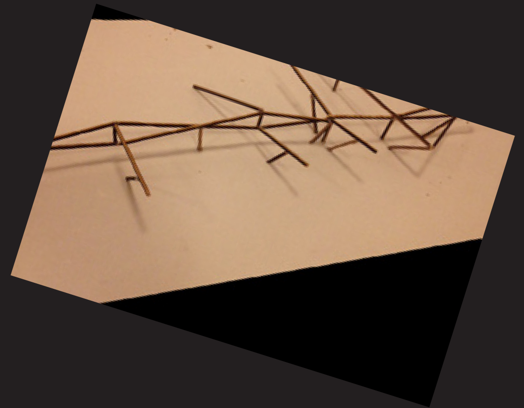
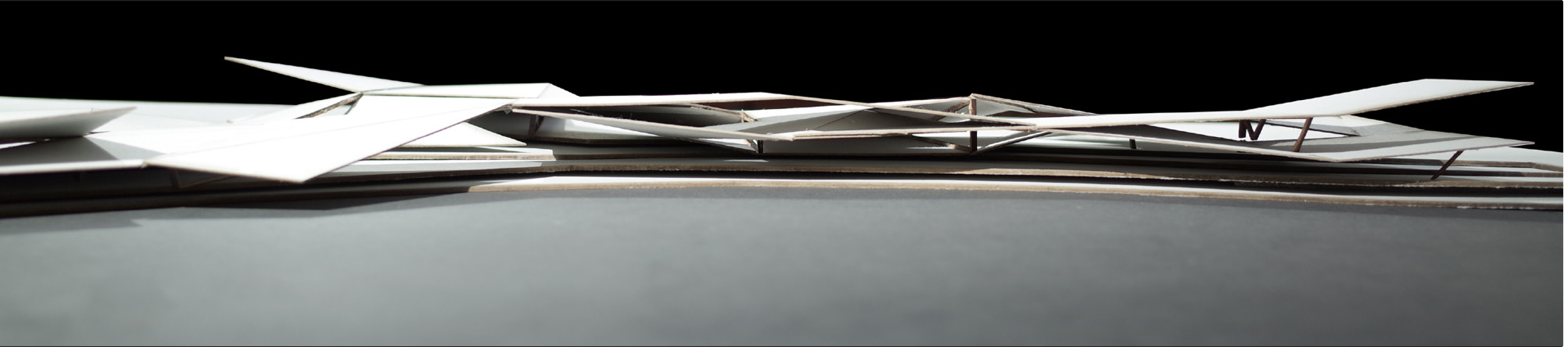
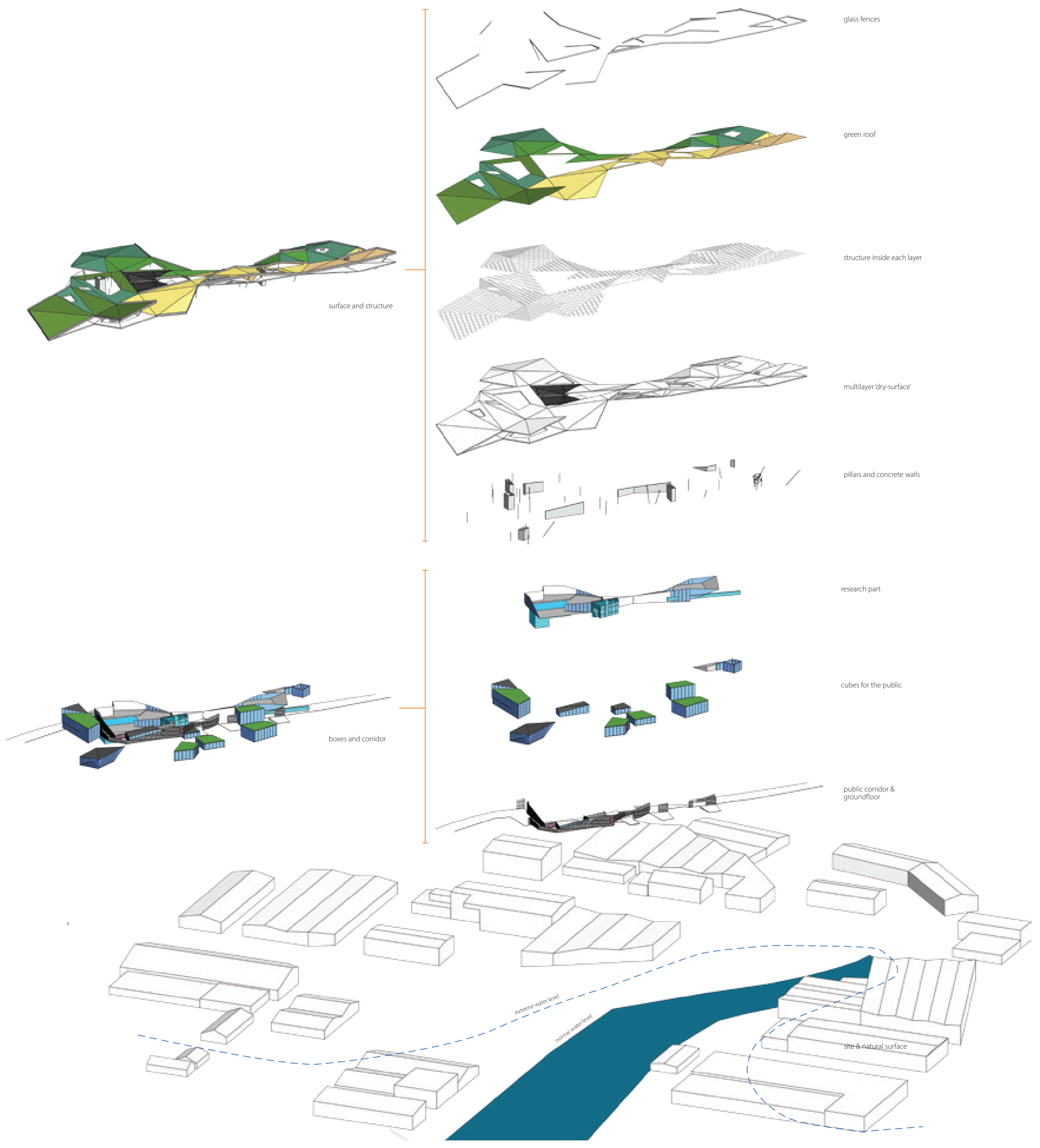
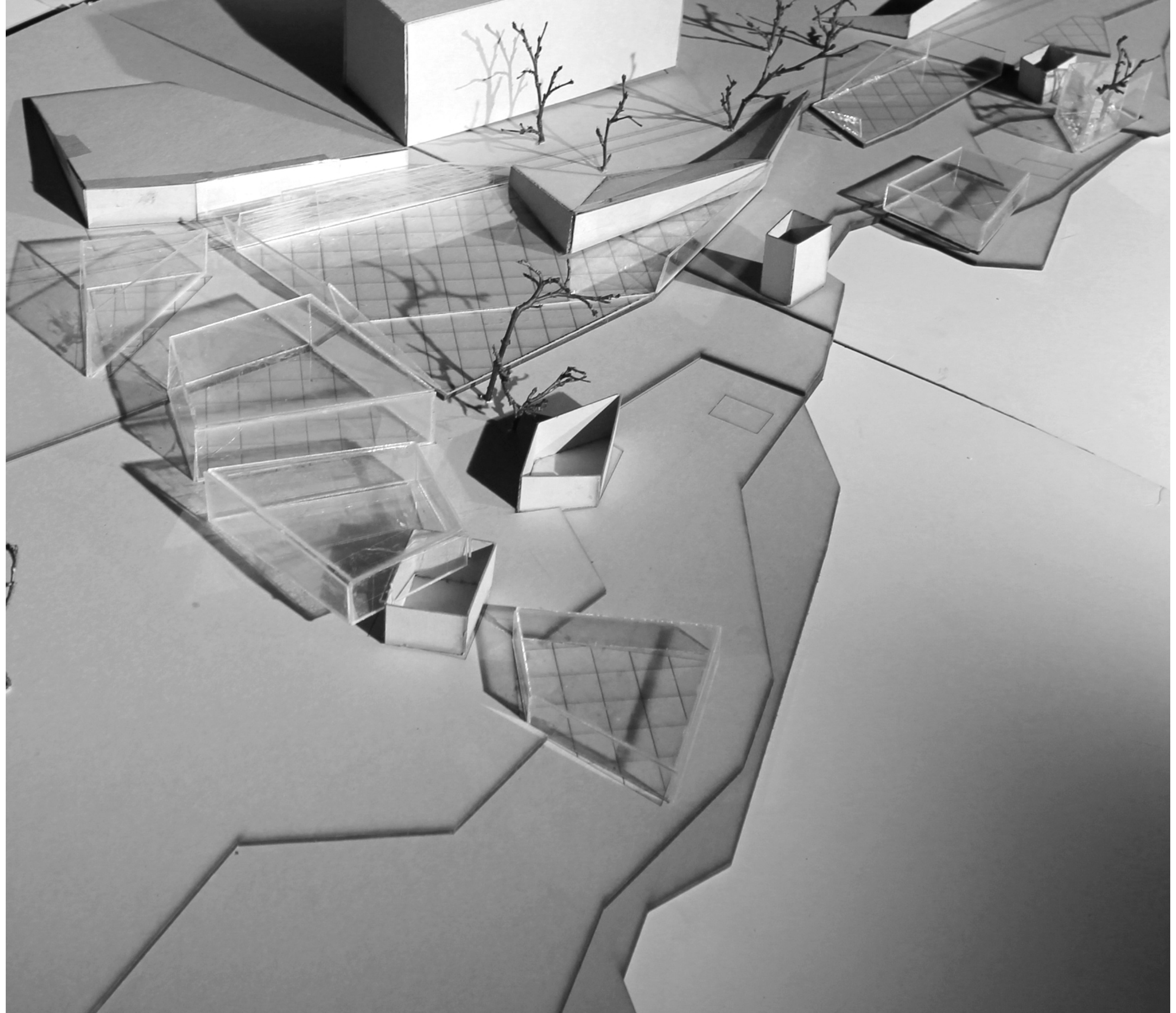
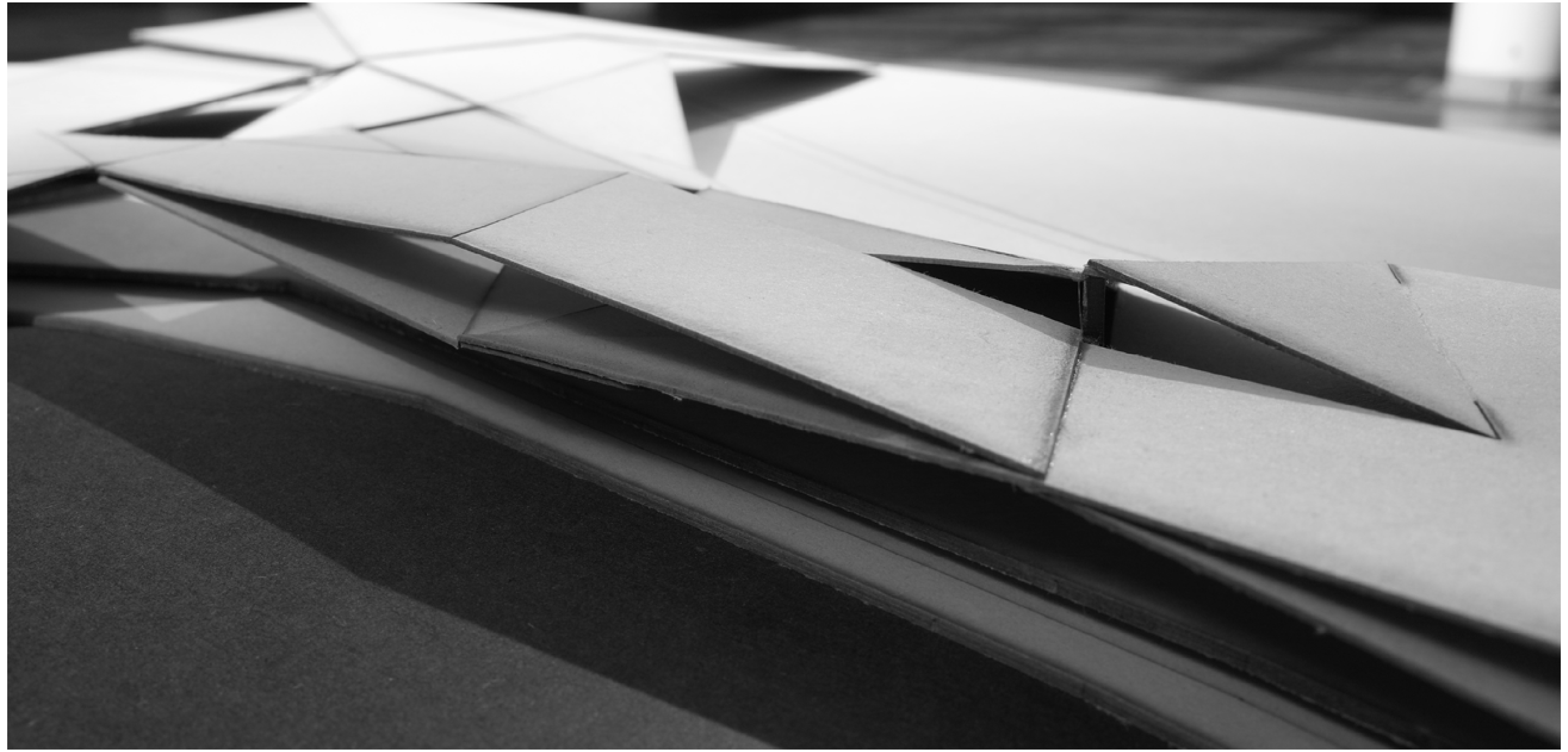
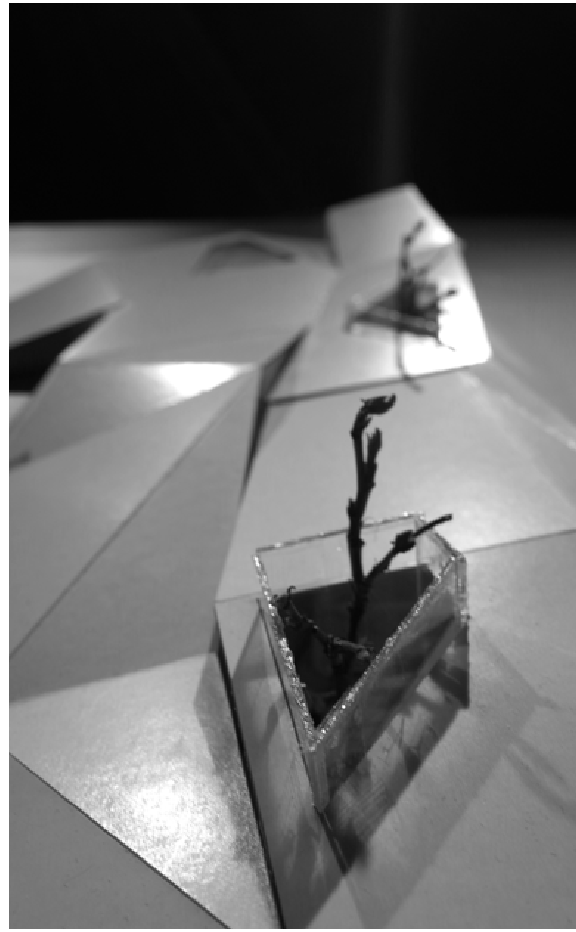





glass fences
green roof
structure inside each layer
surface and structure
multilayer 'dry-surface'
pillars and concrete walls
research part
cubes for the public
boxes and corridor
public corridor &
groundfloor
extreme water level
normal water level
site & natural surface





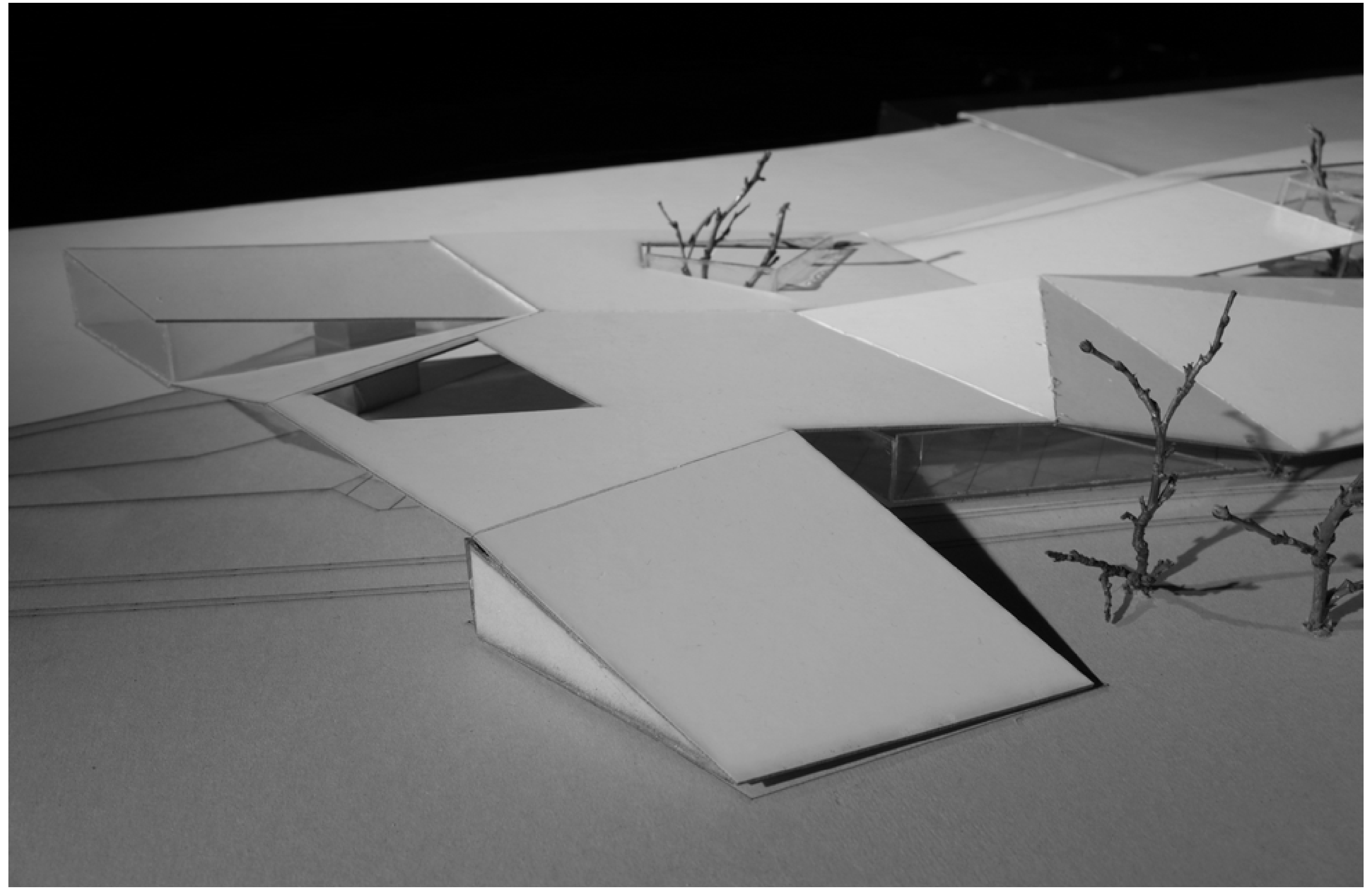
Thickness of Surface

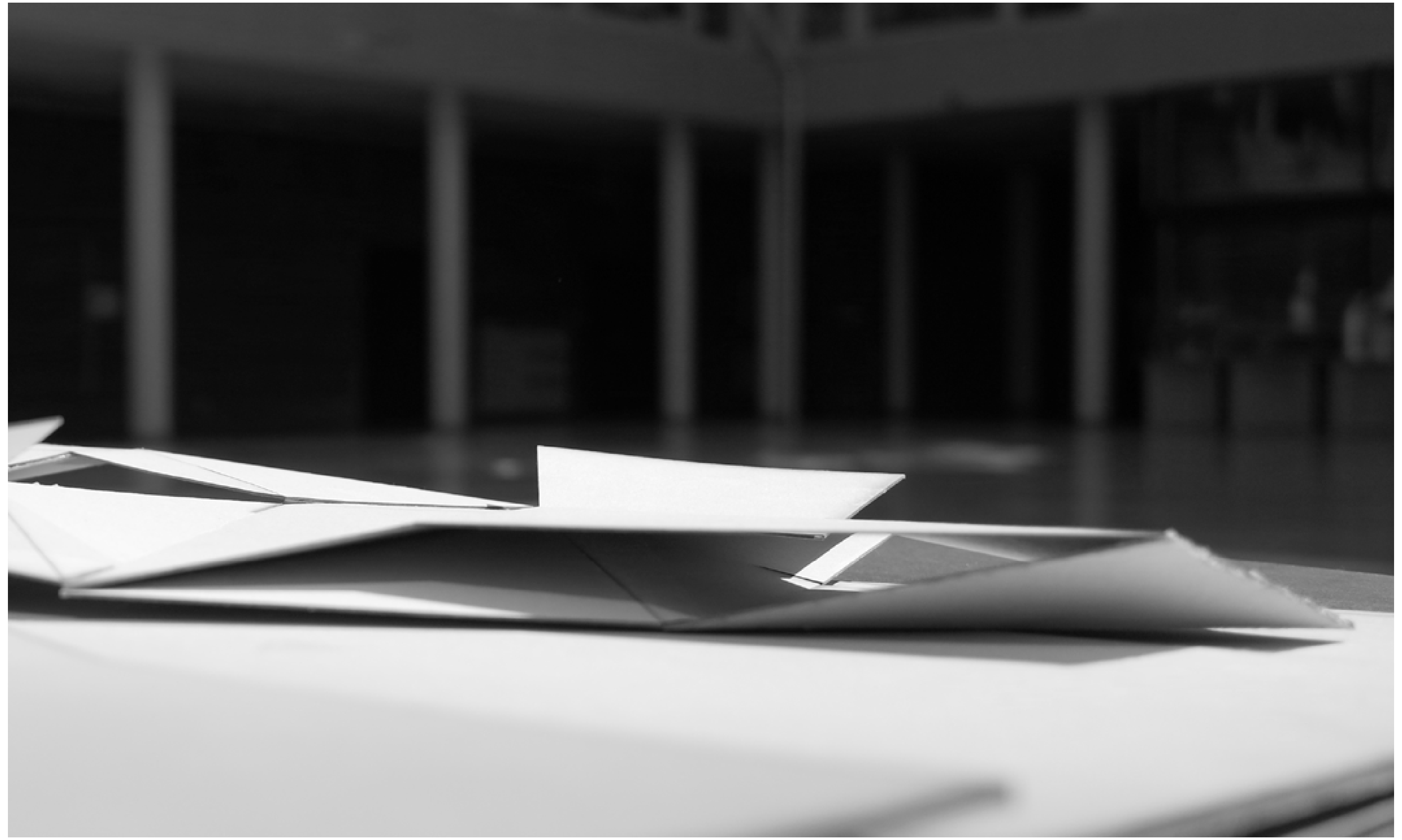
The dry surface
becomes thicker in
some part and it has
space inside.



Multi-layer Connection

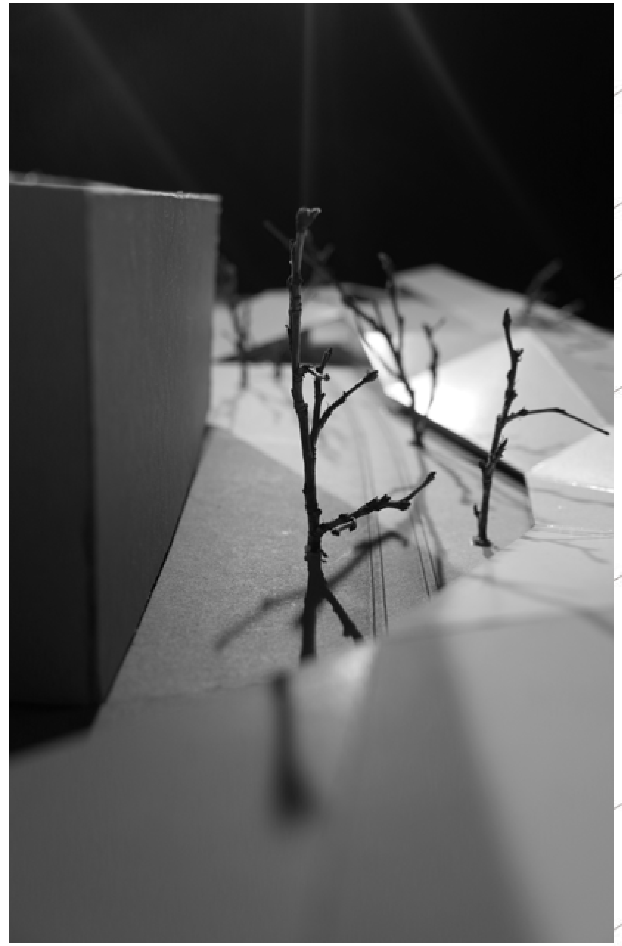
The roof, second layer and ground
floor is connected. So the space of
the building is dynamic, fluent
and in between inside and
outside.





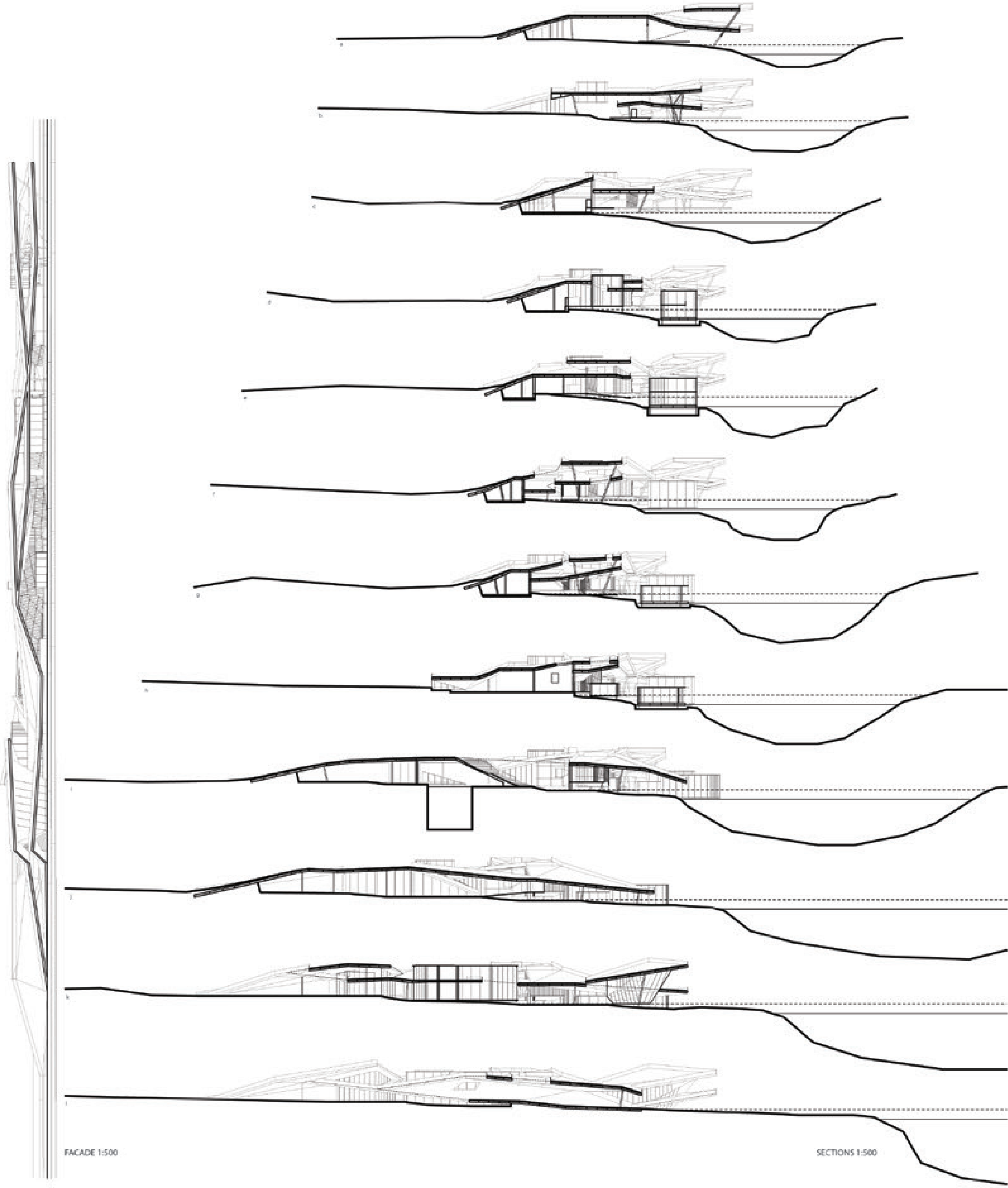
Extension of the park

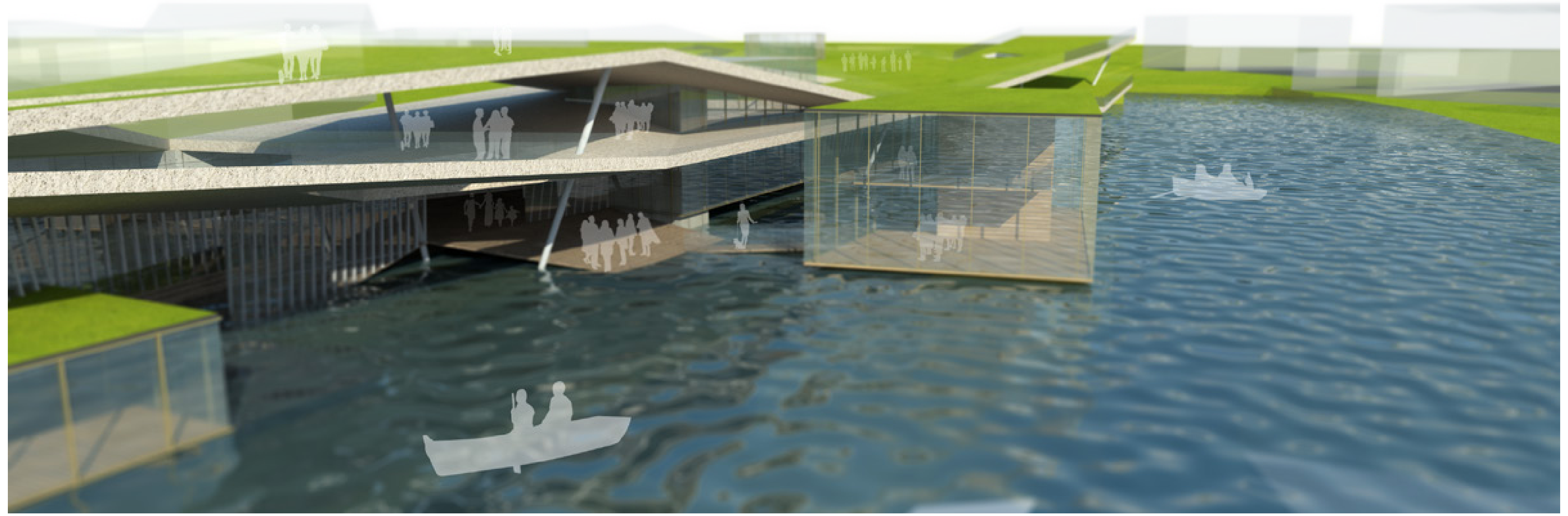
The landform building is an extension
of the park. Slopes closely connect the
context with the roof of the building.



Integration

The landform building integrates existing urban context. Tram line goes under the pedestrian pathways. Accessibility to the river side becomes higher.





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U+A/DL Studio

Friends

My Dad and Mum