RETHINKING THE WATER EDGE
A FLOOD-ADAPTIVE PARK AND RESEARCH CENTRE

CHALMERS TEKNISKA HÖGSKOLA
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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 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.

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

Memory of my hometown
Wuhan, 2007, China

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 from rising sea levels and coastal surges.

- Temperature change & number of people exposed to flood
- European flood city map

ref: http://urbanlabglobalcities.blogspot.se/2012_08_01_archive.html
ref: http://www.nature.com/nclimate/journal/v3/n9/fig_tab/nclimate19011_F3.html
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 the long term perspective.

Reason 1: Sea Level Rise

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.

Reason 2: Extreme Weather Events

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

Gothenburg is already affected by flooding.

Photos ref: Stora översvämningar i Göteborg. sverigesradio.se

Översvämning Nordsta. cherrycheek.blogspot.se
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.

These infrastructures have high failure risks and are very expensive.

http://soundwaves.usgs.gov/2006/01/
AMPHIBIOUS HOUSES AND FLOATING HOUSES

FLOOD BUFFER ZONES

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

SMALL

LARGE

CITY

SOCIETY

Building

Researcher

Public

Water

Region

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/

ref: http://www.wrl.unsw.edu.au/site/expertise/coastal-engineering/...sey-cityhoboken/
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2.1 Ringön: Location & Analysis

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

- **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 managing sea level rise in the long term.

- **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 Statistics**

- **Size**: 700000 ㎡
- **Development Rate**: 300000 ㎡

**Other Development Plans**

- **Backaplan**
  - **Size**: 900000 ㎡
  - **Development Rate**: 700000 ㎡

- **Frihanmen**
  - **Size**: 500000 ㎡
  - **Development Rate**: 500000 ㎡

- **Norra Altvtranden**
  - **Size**: 1400000 ㎡
  - **Development Rate**: 500000 ㎡

- **Sodra Alvstranden**
  - **Size**: 500000 ㎡
  - **Development Rate**: 1500000 ㎡

**2.2 Site Analysis**

- The circulation system for public transportation and pedestrian is insufficient.
- The site has its own well-designed street structure but it is not well connected with surrounding urban areas.
- Only bus line 47 has stops on the site. No tram lines.
- 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 are 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 pedestrians. Ringon provides a lot of jobs.
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2.3 Site Issues & Strategies

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

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SITE 1
BORDER CONDITIONS

Site Flooding Map

Site Ground level: +11.1 to +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 municipality. 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 separated. It will block the view of water. Another risk is the risk of infrastructure failure which would cause disasters.

River Bank Spatial Optimizing

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


ISSUE 2
LAND CONDITIONS

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.

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

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

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

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

Green Roofs

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

Sidewalk Rain Gardens

- A rain garden can collect rainwater, filter pollutants, and help reduce flooding.

Existing Buildings' Roof

- A green roof on existing buildings can improve stormwater management and reduce heating and cooling costs.

Abandoned Railway

- Transform abandoned industrial elements to landscape which can absorb rainwater and provide habitat for creatures.

Abandoned Storage lands

- Much of the empty land near the river bank could turn into a green area which may help 71% shallow infiltration and 63% deep infiltration (runoff 33%).

Green Park

- By planting green roofs, facades to green parking, natural drainage area, the rain loss can be reduced by 20% and 25% instead of 10%.

STRATEGY 2
Absorb Water

Increase absorption of water by transforming impervious surfaces to natural ground cover such as parks, green roofs and storm water gardens.
Current Programmes Of The Site

Transforming Period

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

Marine Companies on the site

Harbour Industry
Ship Technology
Swedish Technology Traditions

Knowledge & Technology Innovation

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

- Small Scale Physical Model Simulation: Wave Flume
  - ref: http://www.wrl.unsw.edu.au/site/wp-content/uploads/1m-wave-flume.jpg
- Testing Creatures Lab
- 1:1 Scale Testing, Flooding Houses Testing Field
  - ref: http://www.wrl.unsw.edu.au/site/about_us/downloads/
- 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

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

"The general public even those without a theatre ticket was also encouraged to tour TPAC. The Public Loop is a trajectory through the hidden 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
Problems:
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.
Space Research: Considering the Relations between Research and Public Programmes

Research Model: Relations between New Programmes on the Original Site
3.3 Structure

Folding Based on the Current Conditions

Folding actions
Multi-layer Surface as a Whole Structure

It transmits force to the foundation through the winding floor connecting upper and lower stories without counting the conventional column and girder system.

Steel Structure inside each layer

Roof windows

Skeleton Model 1

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 main side.
glass fences

green roof

structure inside each layer

surface and structure boxes and corridor

multilayer 'dry-surface'

pillars and concrete walls

cubes for the public

public corridor & research part

site & natural surface

normal water level

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

Public have easy access into the building from tram station just under the roof and bus line 47. Slopes to the second layer and to the roof are easily seen from the north plaza.

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

The landform building integrates existing urban context. Tram line goes under the pedestrian pathways. Accessibility to the river side becomes higher. The landform building is an extension of the park. Slopes closely connect the context with the roof of the building.

**Extension of the park**
Multi-layer Connection

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Thickness of Surface

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Integration

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