Urban porosity

CHALMERS
UNIVERSITY OF TECHNOLOGY

Urban Porosity by *Fabiana* Natalia *Tomé* Fernandez
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Examiner: Ana Betancour. Tutor: Carl Johan Vesterlund

Urban porosity

Managing flood-risk areas. Proposal for a wetland park

Climate change is promising regular floods to several coastal-cities in the world.
Gothenburg is one of the most exposed Swedish cities where annual rainfall is expected to increase up to thirty percent. Situated along Göta river and facing future sea level rises, the city is highly vulnerable to flooding. How will Gothenburg adapt to the current challenges brought with a changing climate?

However, flooding is not the only challenge Gothenburg is facing. The city is physically segregated, the inheritance from a modern urban planning still defines its morphology in which neighbourhoods are separated by over-scaled transport infrastructure.
The central area of Gullbergsvass plays a key role in these challenges being widely accessible by public transportation and highly prone to flooding.

The purpose of this thesis is through the metaphor of “urban porosity” to research and develop strategies, tools and methods for adaptation to flooding of coastal-delta cities.
Simultaneously, the study aims to discuss what priorities, in terms of social aspects, are to be taken when planning in flood-risk areas.

The working methodology has been: a mapping of the consequences and contemporary debate on climate change, sea level rising and flooding through: case studies, literature research, scenario analysis, interviews with the city’s planning office and international experts in the subject. In addition field studies and a study visit to the city of Malmö were realized.
This thesis looked at flooding on different levels and scales in order to understand and develop a holistic approach to allow the urban context to enjoy rather than suffer the rains.

The project is for a large scale urban park composed of wetlands, woodlands and urban agriculture functioning as a sponge allowing absorption of water. The park is designed as a space for social inclusion, proposing public activities for the inhabitants, aiming to contribute towards the development of a sustainable future for Gothenburg.
The proposal is conceived as an open-ended design, establishing a set of guidelines and strategies, and a framework for a design process and definition of the architectural elements over time.

To:

Ana Bentancour, Carl Johan Vesterlund and *UADL* for their support and for welcoming me to write this thesis in the studio.

The University of Tokyo and the Asian Institute of Technology through the programme *Ipos* for inspiring me to choose the problematic of Climate Change for this work.

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THANK YOU !!!

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Introduction

Climate change is promising regular floods to several coastal and delta cities in the world.
The Fourth Assessment Report by the IPCC[1] forecasts an increase of four degrees in the global mean temperature and sea level rises by 2100. The increase in temperature will be followed by a change of the earth's rainfall pattern producing a different scenario according to different latitudes. Some regions will become drier and other wetter. However, in both cases, extreme weather events are expected to take place more often and with stronger effects, increasing the exposure of coastal and delta cities to flooding.
How would the future of these cities look like if climate change continues?

In Sweden, Västra Götaland is one of the most exposed regions to climate change and in which rainfall is expected to increase with and between 10 and 30 percent[2]. The region's driving city, Gothenburg, being situated along Göta river and facing future sea level rises, is highly vulnerable to flooding.

Problem area delimitations
The municipality of Gothenburg, actually facing a severe housing shortage, plans for 40.000 new jobs and 30.000 new dwellings by 2020 within the city's central areas in order to strength its position within the region[3].
The riverbank adjacent area of Gullbergsvass, centrally located, is a hot spot for development as many other ex-industrial urban areas around the globe.
These waterfront areas are well demanded for their relationship with the water but also for their strategic situation within the city-scape.

The development of Gullbergsvass and Gothenburg's river adjacent areas supposes great challenges taking into consideration a climate that is changing.

How will Gothenburg adapt to climate change?
How would Gullbergsvass, if developed, adapt to flooding?
Or perhaps the question rather pertinent is: what kind of development will allow Gullbergsvass adapt to flooding?

Gothenburg is besides physically segregated, the city districts are separated from each other by over-scaled transport infrastructure transforming the city in different “interconnected” islands. From a social point of view one may recognise these islands as gentrificated neighbourhoods being some of them centrally located and other towards the edge of the settlement.
The suburbs where low-income families and high percentage of immigrants live, are an example of these gentrificated islands and supposes another great challenge for Gothenburg in terms of social sustainability.
Several strategies to cope with floods includes green structures, therefore, it is interesting to establish the question, can flood adaptation systems be utilized as a tool for social inclusion?

Aims and objectives
The purpose of this study is through the metaphor of “urban porosity” to research and develop strategies, tools and/or methods for adaptation to flooding and thus to climate change of coastal-delta cities.
Simultaneously, the thesis aims to discuss what priorities are to be taken, in terms of social aspects, when planning in flood-risk areas.

Method and theory formulations
In order to explore and develop strategies for adaptation to floods and thus to climate change for coastal-delta cities, the urban context of Gothenburg was taken as case study, utilizing the area of Gullbergsvass as a test bed.

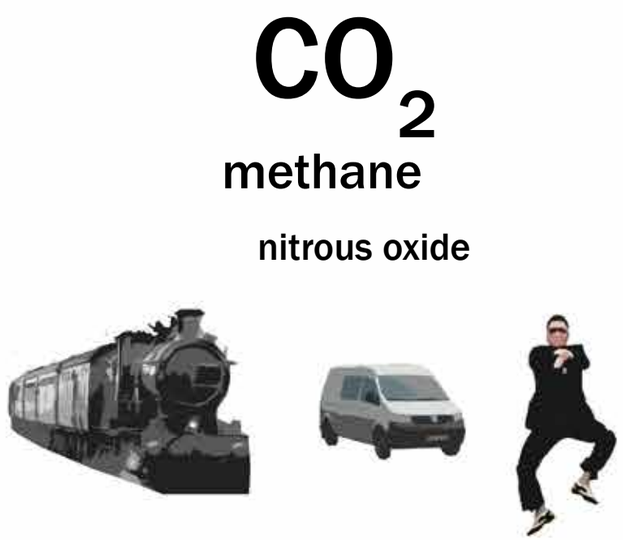
The way of examining Gullbergsvass has been with regard to the landscape, understanding the natural conditions and processes along the river, trying to strength the natural relationship between river and land, however, not forgetting the city-scape, its history and development. Therefore, this thesis looked at flooding on different levels and scales in order to understand and develop a holistic approach to allow the urban context to enjoy rather than suffer the rains.

The working methodology to approach the issues has been: a mapping of the consequences and contemporary debate on climate change, sea level rising and flooding through: case studies, literature research, scenario analysis, interviews with different sections of the city's planning office and international experts in the subject. In addition field studies and a study visit to the city of Malmö were realized.

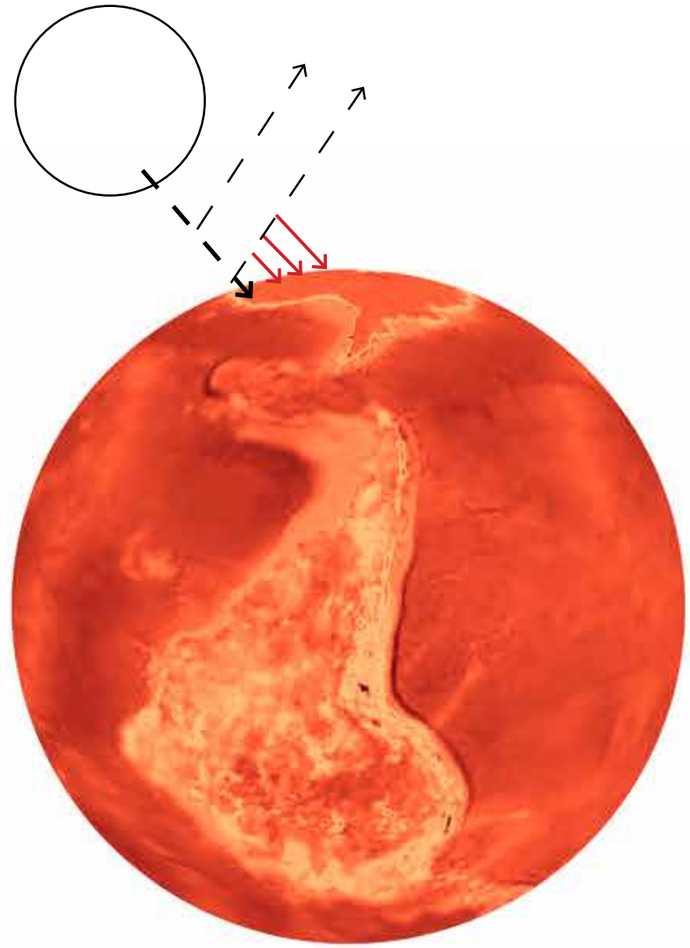
1 Intergovernmental Panel on Climate Change
2 REposition (2012)
3 Göteborgs Stad (2009) a

the greenhouse effect

Television, newspapers, radio, internet all sorts of communication warns us about climate change and about how we are warming up our planet by the lifestyle we are living. We are expected to decrease our consumption of energy in order to decrease our CO_2 emissions, but what is all of this about? What means climate change?



We may start by accepting that we owe our climate to the green house effect. Our planet has an average temperature of 15 °C thanks to the absorption of sun radiation by greenhouses gases within the atmosphere. Without this phenomenon our planet would be as cold as -18 °C in the global mean.[1]



Anthropogenic activities have producer a higher concentration of some greenhouse gases such as CO_2 and methane. As this concentration increases more radiation gets trapped and absorbed by the atmosphere making our planet warmer.

1 Fujisaki, K (2011)

A warmer planet implies consequences we are already being witnesses of. The change in the rainfall pattern is making some regions to become drier and others wetter; the melting of Antarctic and Greenland ice sheets, glaciers and ice caps, as well as the thermal expansion are determining our sea levels to rise.[1] Coastal-cities like Gothenburg are highly exposed to flooding for their low-lying conditions.

The way of illustrating the planet which may looks as it is upside-down is inspired by the work of the Uruguayan artist Joaquin Torres García “América invertida” (inverted America) 1943.
Google maps were used to produce the images.

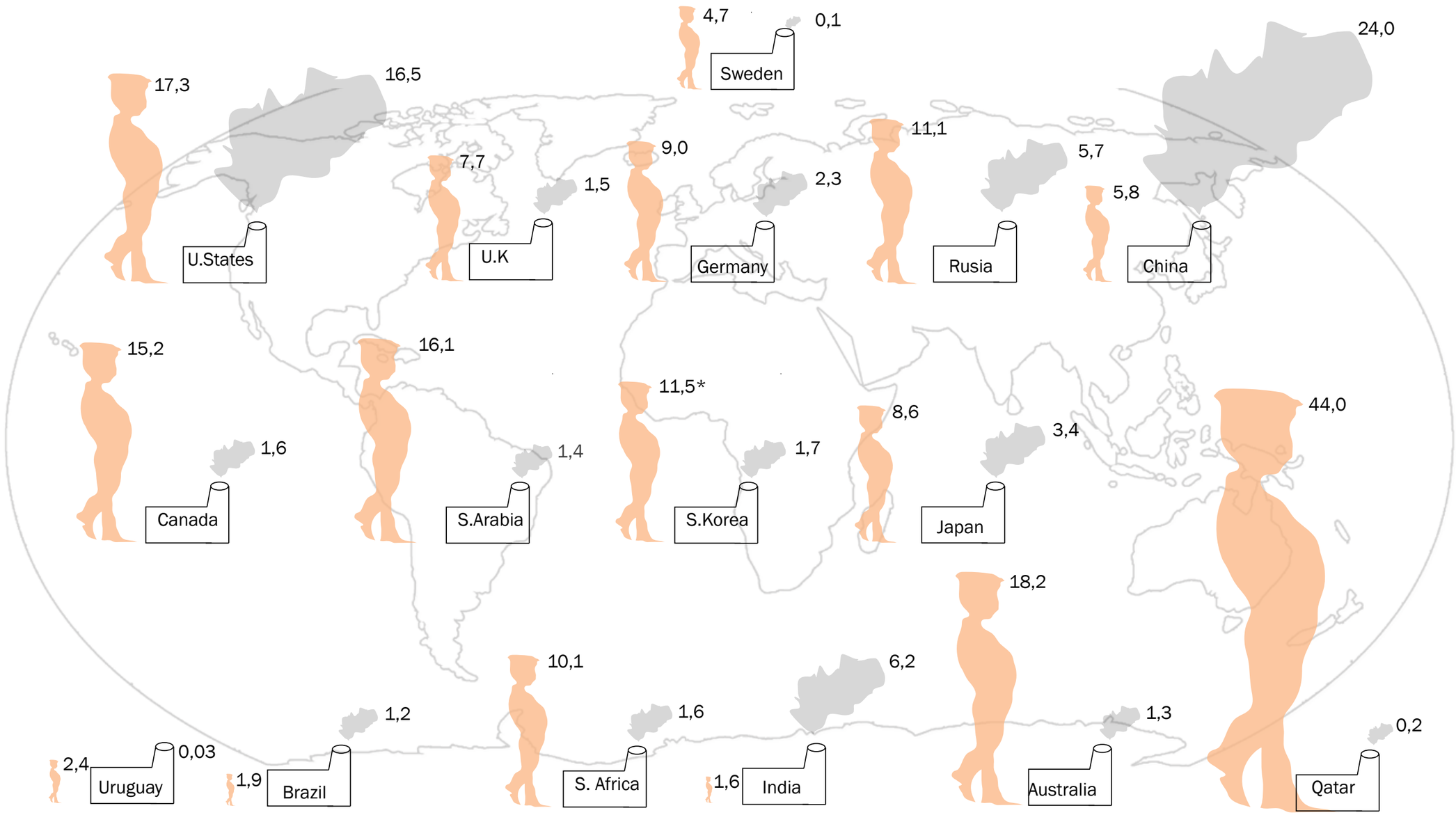
The graph on the following page shows a comparison between countries with high CO_2 emission per person and with high share of the global CO_2 emission. What would happen if Chinese and Indian adopt a lifestyle as Canadians or Australians?
One may identify developing countries but specially China and India as well as developed USA playing key roles in the success or failure of a future decrease in the global CO_2 emission because of their actual high influence within the global share. Despite of this fact many countries still do not have a goal to reduce CO_2 emissions as denounced by the Swedish minister of environment[1].

Other countries like Sweden and Uruguay were included in the graph despite their little global impact because of the thesis aim and the author’s personal interest.

1 IPCC (2007) b

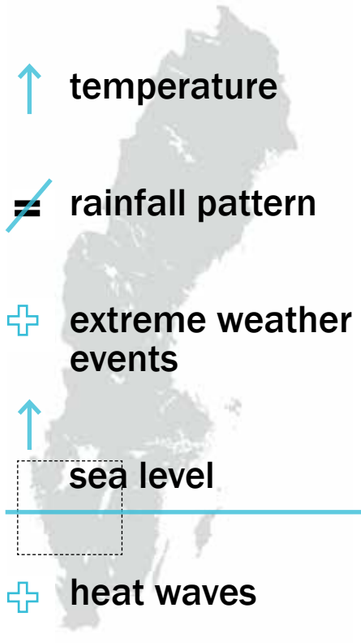
1 Orre, S. (2012)

lifestyles and CO_2 emissions



Adapted from Fujisaki, K. (2011) with data from The world Bank (2009), Wikipedia (2009) and Doha News (2011).

Sweden



temperature

rainfall pattern

extreme weather events

sea level

heat waves

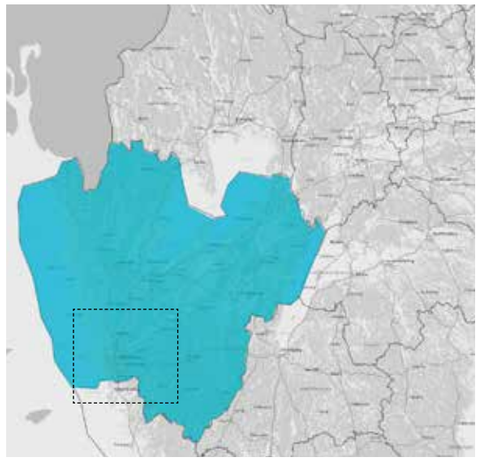
landslides
(increased water velocity and eroded riverbanks)

floods

In Sweden the temperature is predicted to increase making the rainfall pattern change, rainy winters, springs and autumns as well as hot dry summers are expected.[1] More often extreme weather events and sea level rising are also awaited as a result of dlimate change.

1 Swedish Government Official Reports (2007)

Västra Götaland

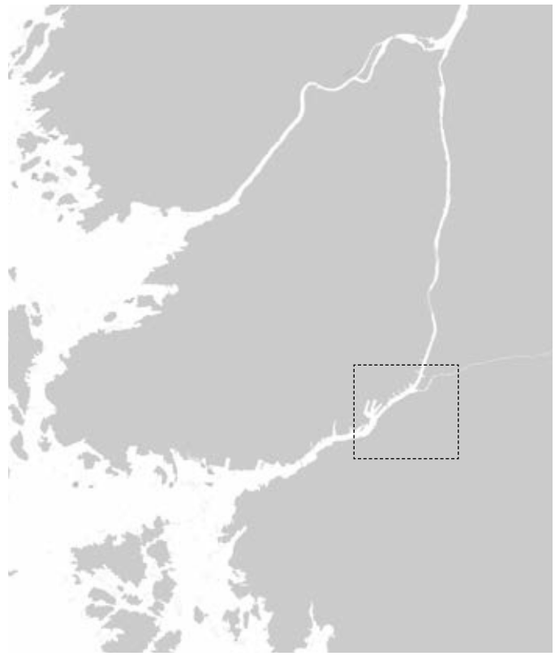


By 2100
the annual rainfall average over the region will increase with 10-30%.

Greater risk of floods, heat waves and landslides are then the main consequences supposed to come along with this change.
West Sweden (Västra Götaland) is one of the most exposed regions in which precipitations are supposed to increase with 10 and 30 percent .

Google maps and maps from lantmateriet.se were used for the illustrations.

Gothenburg

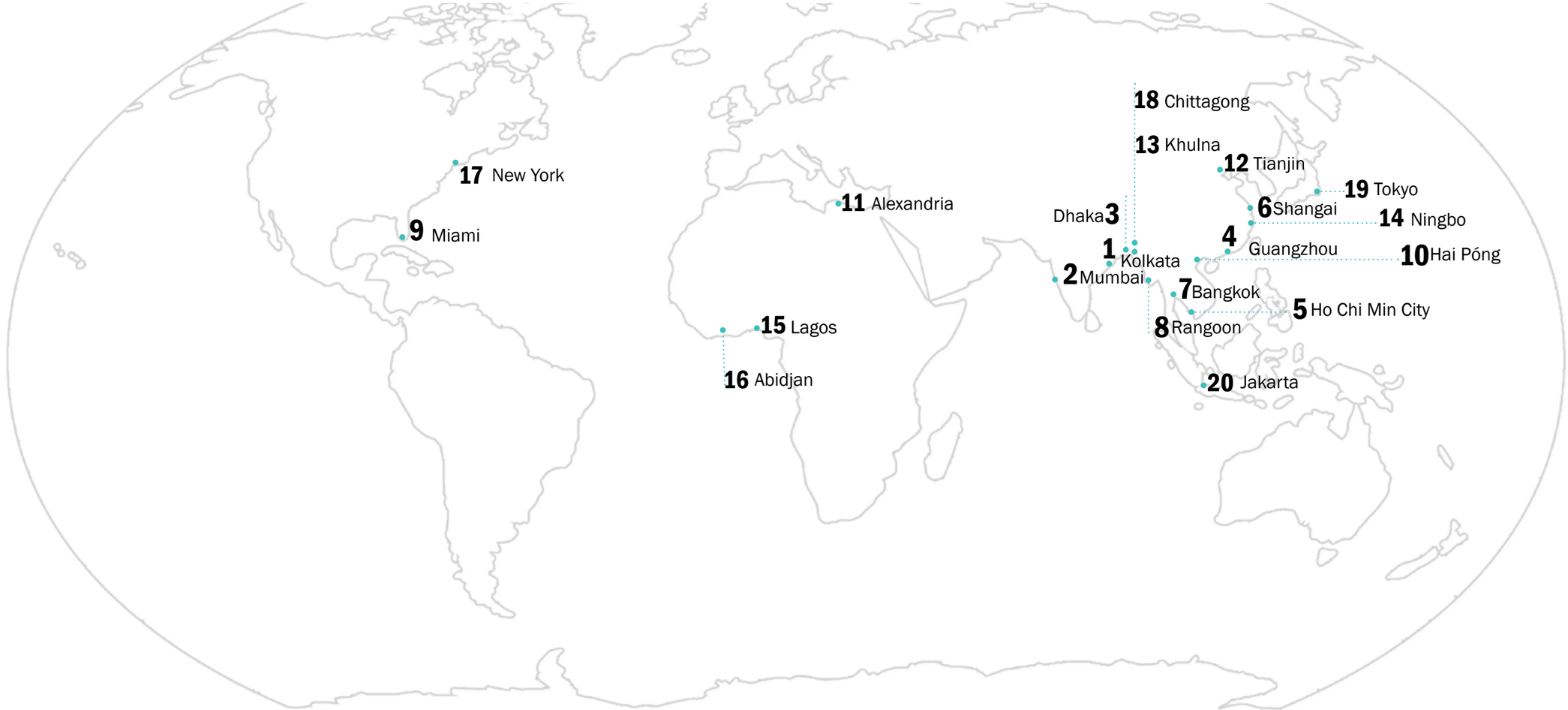


The city with an annual precipitation of c. 900 mm.[1] is the most exposed to floods in Sweden considering living and working facilities[2].

Gothenburg though is not alone! There are many cities in the world that are also likely to be affected by climate change and the flood problematic.
Therefore a graph on the following page showing the 20 most vulnerable cities by 2070 in the world is presented.

1 SMHI (2013) a
2 Myndigheten för samhällsskyd och beredskap (2011)

delta cities **vulnerability hot spots**



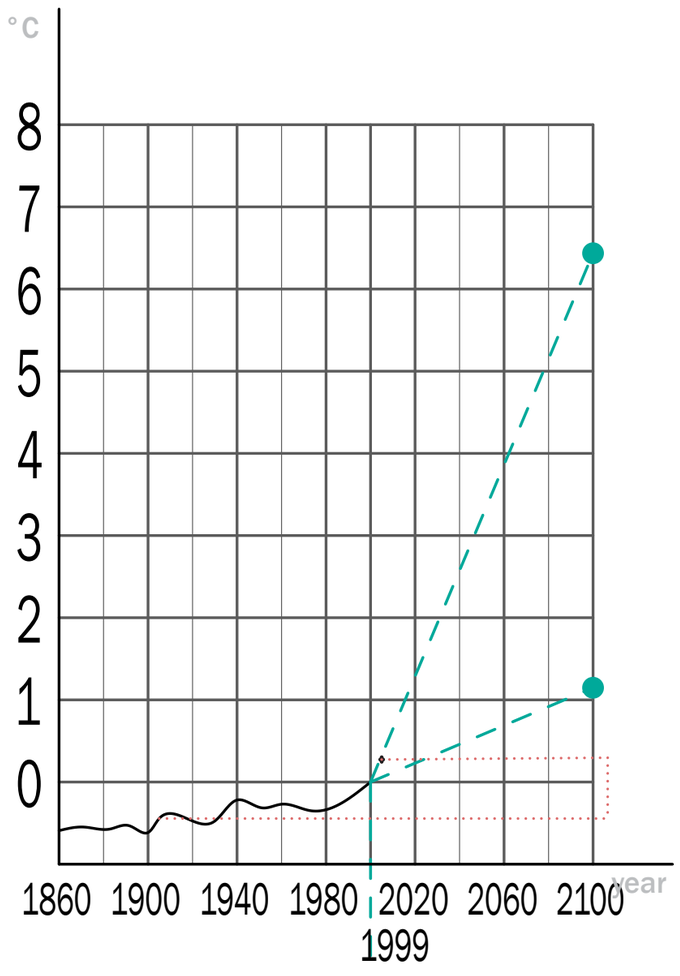
This graph shows the most exposed cities by 2070's.
Illustration with data from Nicholls, R.J. et al.(2008)

global warming

This graph[1] shows the expected temperature increase by 2100 for the scenarios SRES A1FI and B1 as well as the recorded trend between 1906-2005 described within the IPCC Fourth Assessment Report (AR4).

The mentioned SRES scenarios makes reference to the Special Report on Emission Scenarios delivered in 2000 by the IPCC, in which, different possible development ways for the future of the world were explored. Four scenario families A1, A2, B1 and B2 were generated from different association of the following variables: demography, economy and technology.
The A1 supposes a world that reaches a population peak by 2050, very rapid economic growth as well as rapid introduction of new technologies. Moreover A1 is sub grouped according to the last mentioned variable into: A1FI: fossil-intensive, A1T: non-fossil,and A1B: balanced energy resources. B1 describes a world likewise A1 in terms of population, though different in terms of economy structure leading towards an economical system based on service and information. The B2 scenarios bases on a world with intermediate population and economic growth and technology development toward local solutions. A2 assumes a mixed world with advanced population growth but with slow economic and technological development.[2]

The two scenarios which have been selected for this thesis A1FI and B1 represents “the worst and the best” respectively in its prognosis of temperature increase and sea level rise. One may observe that the recorded trend is following the path towards the scenario A1FI and that is the worst case expected in AR4.



+ 6, 4 °C scenario A1FI

+ 1, 1 °C scenario B1

+ 0, 74 °C (1906-2005 recorded trend)

1 Adapted from IPCC (2007) b
2 IPCC (2007) a

sea level rise

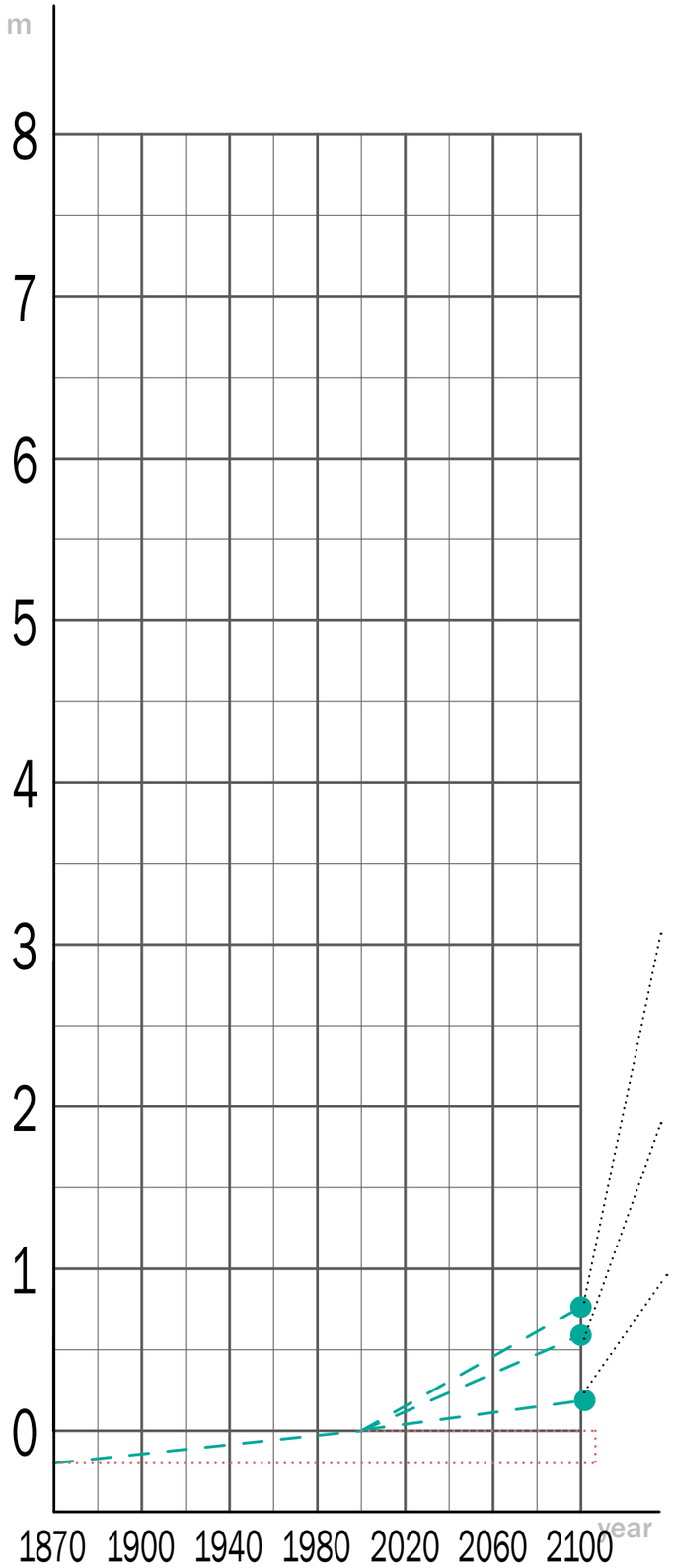
different scenarios and perspectives

This graph is showing sea level rise for the same scenarios mentioned before : A1FI and B1 as well as the recorded global sea level rise between 1860 and 2000 of 0.2 m.

Parallel to the increase of temperature a 0,59 m increase in the global mean sea level rise is expected for the scenario A1FI and 0,18 m for the B1.
The North and the Baltic sea are supposed to rise 0,2m above the global mean which would entail 0,79 m and 0,38 m sea level rise respectively by 2100.

These scenarios are considered far too conservative by the scientific sphere because they do not include future rapid dynamical changes in the ice flow[1].

Already on the previous report TAR (Third Assessment Report) published by the IPCC it was expected a higher rise of the sea level which is described on the following page.



+ 0, 79 *
(0, 2m higher is expected for the Baltic and North sea)

+ 0, 59 scenario A1FI*

+ 0, 18 scenario B1

“excluding future rapid- dynamical changes in ice flow”

+ 0, 2 **(1860-2000 observed global sea level rise)**

1 Connor, S. (2009)

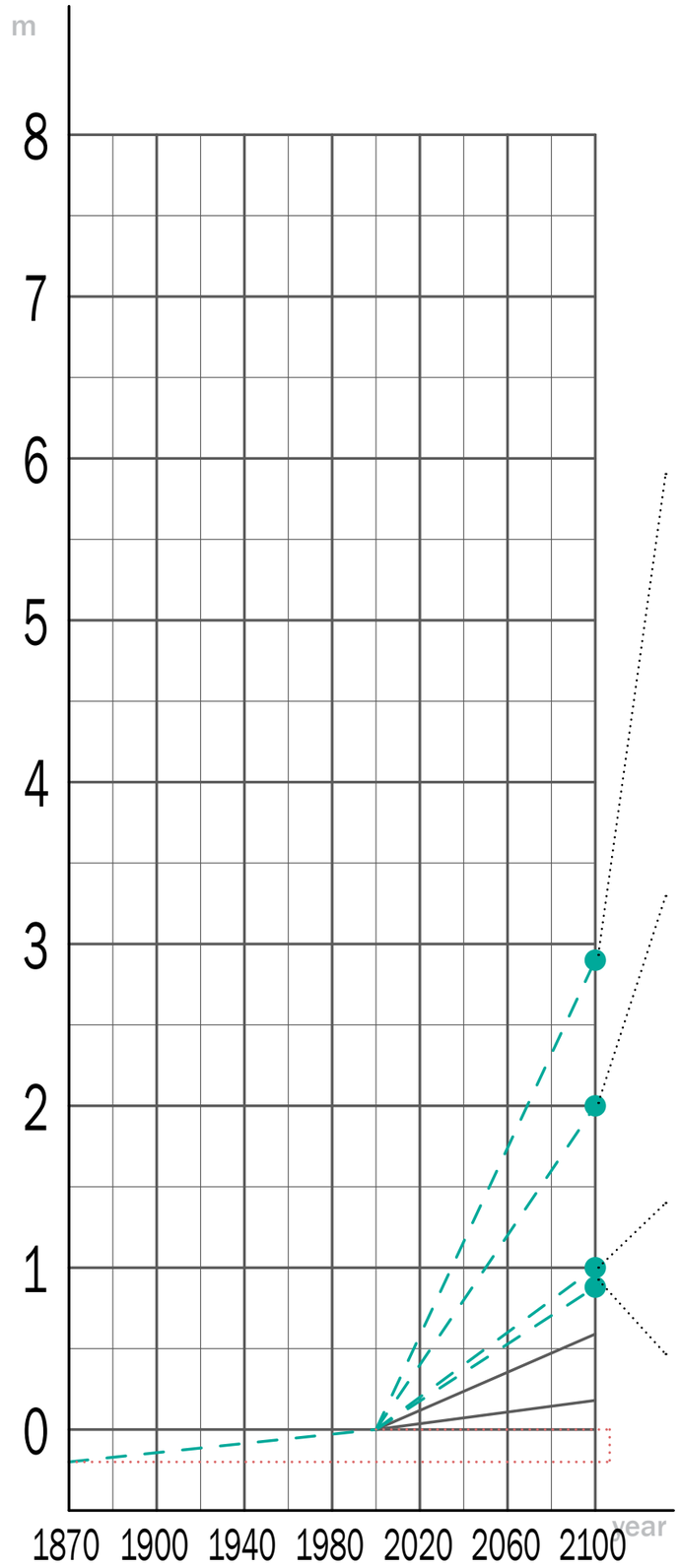
sea level rise

different scenarios and perspectives

So how much can we expect the sea level will rise? This graph gathers different scenarios adopted by different institutions in Sweden together with the TAR projection[1] mentioned before.

+2.9 m is the future high water level for Gothenburg managed by the regional Authority that recommends not to build anything below this level because of its vulnerability to flooding. [2]

+2 m is the level adopted by the traffic office in Gothenburg to protect vital functions of the city [3] and 1 m is the scenario adopted by the Swedish government.[4]



+ 2, 9 future high level for Gothenburg
according to Länsstyrelsen of Västra Götaland which recommends not to build but recreational areas up to this level

+ 2, 0 security level
adopted by the traffic office in Gothenburg to protect vital functions of the city

+ 1, 0 Swedish adopted scenario

+ 0, 88 TAR projection

1 IPCC (2001)
2 Länsstyrelsen i Västra Götalands län (2012)
3 Göteborgs Stad (2009) b
4 Swedish Government Official Reports (2007)

sea level rise

different scenarios and perspectives

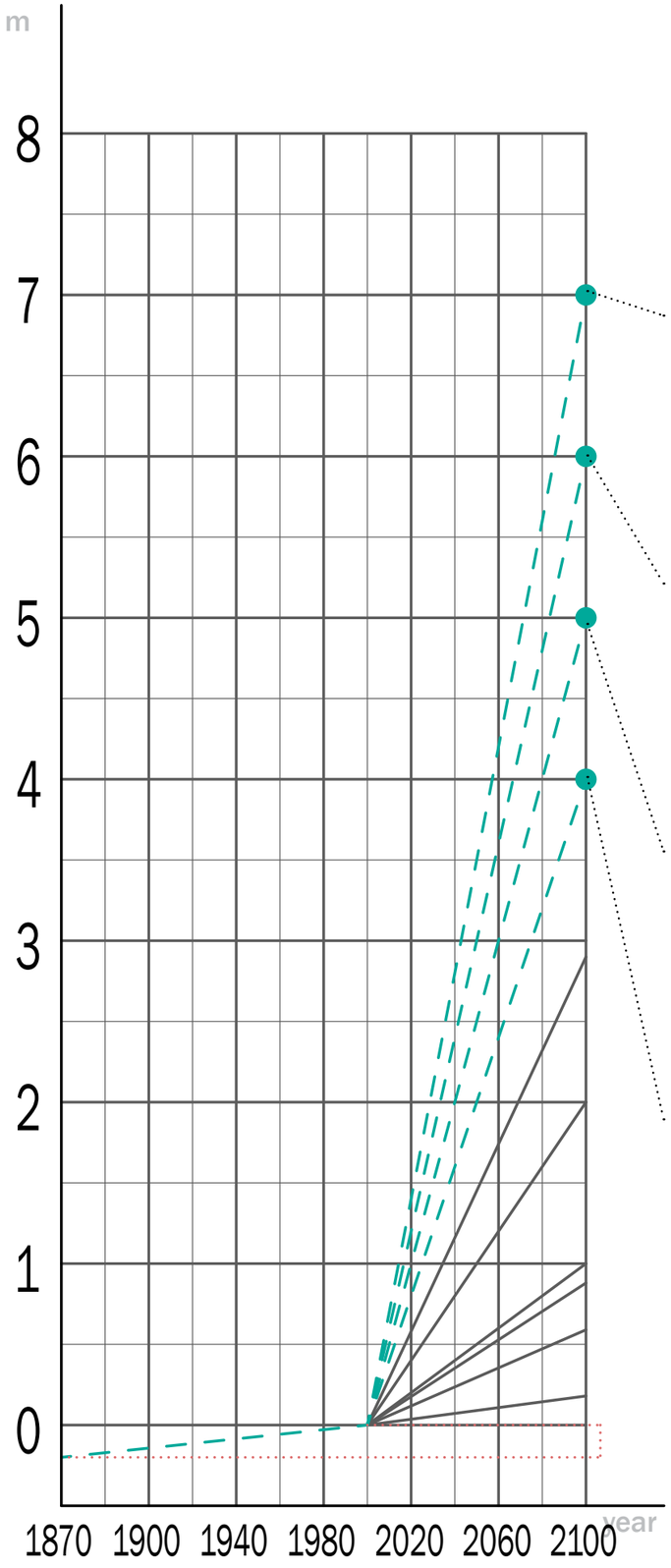
This graph broadens still more our prospective presenting facts and a curious perspective.

To begin with, the Palaeoclimate perspective explained also in AR4, is very peculiar because it explains how our climate was 125.000 years ago and how high the sea level was.
In that age the Earth was between 3 and 5 degrees warmer than it is today, and the sea level was 4 and 6m respectively higher.
If we consider that the average temperature could increase between 1 and 6.5 degrees as mentioned in page 16 one may wonder if we are going to repeat history and sea level would rise consistently more than the correspondent scenarios of 0,18 and 0,59 m.

The inclusion of this perspective within this work pretends to provide a bigger picture of what climate change could imply for the world. Furthermore it shows that there is still no right predictions or answers to what we are facing.

The graph is besides including the contribution that Antarctica and Greenland ice sheet could make to sea level rise if they were to melt completely.

After reading all this different scenarios we may experience headache and confusion but certainly we would understand that there is great uncertainty of what is going to happen, the only truth and sometimes hard to accept is that this is already happening and we do not know how it is going to develop. Appropriated technology is lacking to determine precisely how many meters sea level will rise but that it is rising nobody has any doubt of.



+ 7, 0 Greenland ice sheet
contribution if melted completely

+ 6, 0 Palaeoclimate perspective
with temperature increase of 5°C

+ 5, 0 West Antarctic ice sheet
contribution if melted completely

+ 4, 0 Palaeoclimate perspective
with temperature increase of 3°C

In order to deepen the understanding of the scenarios described before and aiming to select some of them as a starting point to evaluate a future situation for Gothenburg this thesis consulted different municipality technicians and also an expert from Thailand, were the flooding issue is challenging the country.

The interviewed Ph.D candidate Thitirat Chaosakul who researches among other subjects on the impacts of climate change on hydraulic performance of drainage systems explained that the challenges she encounters when designing are the uncertainties in prediction in this case of future rainfall causing the design to be unreliable.

Uncertainties were likewise the problem faced by the municipality of Gothenburg though in this case regarding future sea level rises.

The area of Gullbergsvass was the center of the interviews realized as it is utilized in this thesis as a test bed to research on methods and strategies to adapt to floods and climate change.

This area as mentioned before is highly vulnerable to floods and it is awaited to be redeveloped together with other central areas in the near future as it appears in the Comprehensive plan for Gothenburg (please see next page). The image though has been adapted in order to show the topographic qualities that these ones have: flat, easy land to develop.

“Much porosity less flooding”[1]

1 Thitirat Chaosakul, Ph.D candidate from AIT, Thailand, assessment of impacts of climate change on hydraulic performance of drainage systems, e-mail interview 5-03-2013.

Gothenburg has a shortage of housing and plans to build 30.000 dwellings and give place to 40.000 new jobs in the near future. These old industrial areas appears then as strategically located and extensive enough to redevelop as the industries are fading away.

Other areas which could be also develop are seen by developers as problematic for its rocky topography as it is the area of Hammarkullen where locals are positive to receive more dwellings in order to densify their neighbourhood hoping to attract more services.
But one may wonder if redeveloping these central old industrial areas is the best solution for Gothenburg taking into consideration a climate that is changing.

On the following pages a vast analysis of the city, the river’s catchment area and specially of Gullbergsvass is presented aiming to answer whether we agree or not with the municipality plans.

This analysis has been done following the scenarios managed by the municipality of 1m and 2m sea level rise and considering the case of extreme weather event using the statistical value of 1,7 m recorded at Ring Ön the 4th December of 1914[1].

1 SMHI (2013)b

Gothenburg

comprehensive plan

1_ Outer Areas- future development areas

2_ Intermediate city

3_ Coastal Areas/ Archipelago

4_ Central Gothenburg- Inner city

5_ Nature Areas

6_ Large scale industry, the port and logistics

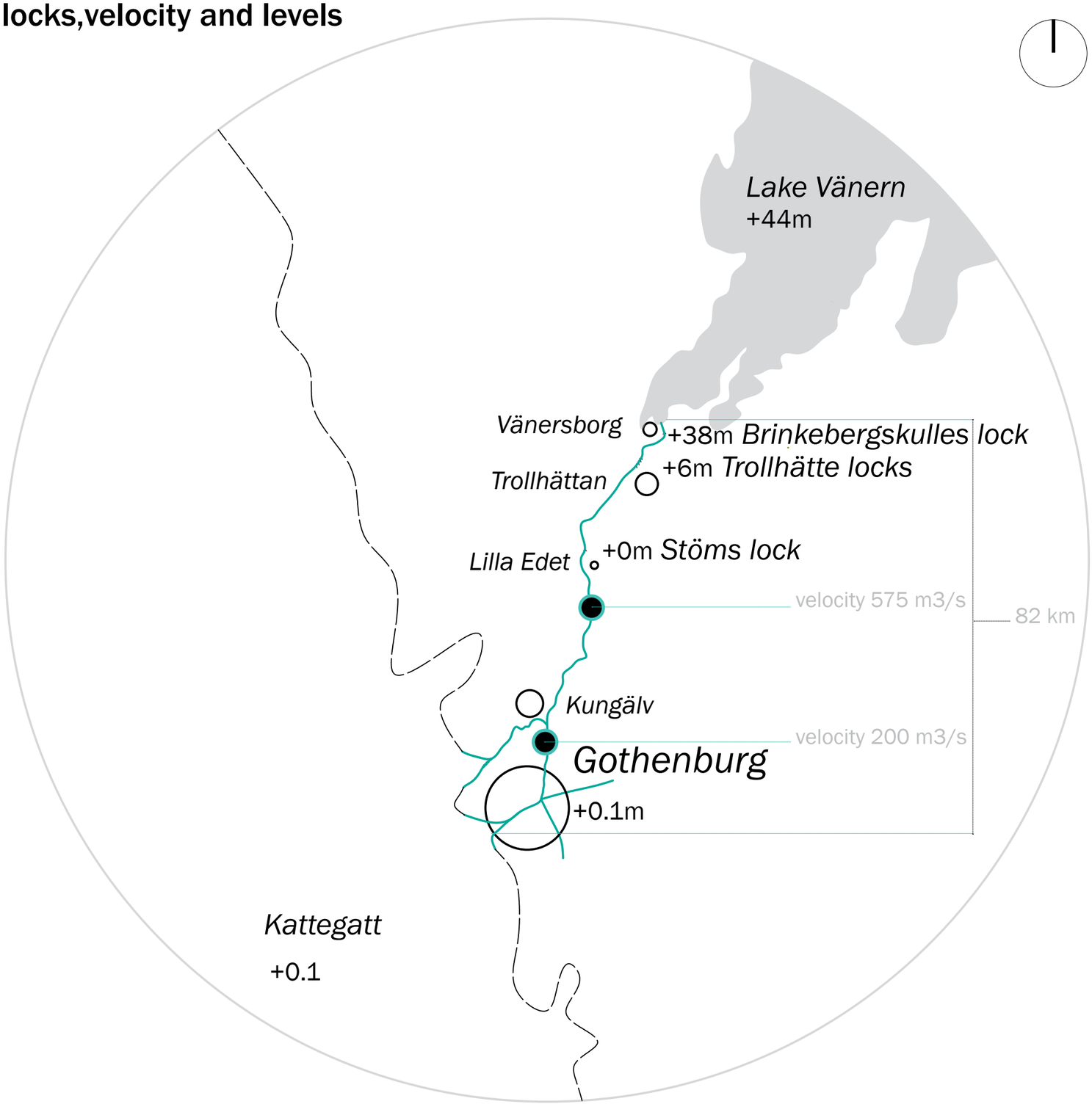
7_ Central Gothenburg- Renewal Areas:

Build mixed developments
Create attractive meeting places and new parks
Improve and make use of contact with the water
Prioritize public transportation, walking and cycling
Improve connections
Achieve good regional accessibility
Concentrate around strategic nodes
Enhance the cultural environment

Illustration adapted from Göteborgs Stad (2009) a. Background map from http://www.maps.google.se

Göta river's catchment area

locks,velocity and levels



Gothenburg is clearly defined by the estuary of Göta river. The river rises at the city of Vänersborg draining from lake Vänern and flowing into the sea c. 82 km downstream at the city of Gothenburg.
The scheme shows the different locks that enables its navigation covering the difference of levels of 44 m.
The scheme shows likewise the cities settled along its margins as well as its velocity in some points.

On the next page a scheme over the mouth of the river is displayed in order to better understand the situation of Gothenburg. Göta river discharges as mentioned before in Kattegat but before the river splits giving place to the Nordre river where 75 percent of the water flows. Therefore just 25 percent continues through Göta river and Gothenburg.

Additionally it is shown the movement of the water through the flood plain (Gullbergsvass-Ring Ön) where salt and fresh water meets and also the tributaries to Göta river: Mölndalsån, Saveån,and Kvillebäcken.
Mölndalsån though meandering artificially through a culvert in order to accommodate urban infrastructure.
This fact produces even more tension in that area as this tributary is piped like one does with storm water disabling it to expand if the volume of water increases.

Illustration adapted from Hedlund, L. et al.(2009) with data from Sjöfartsverket (2013), Wikipedia (2013) and Google maps.

Göta river's mouth

water movement scheme

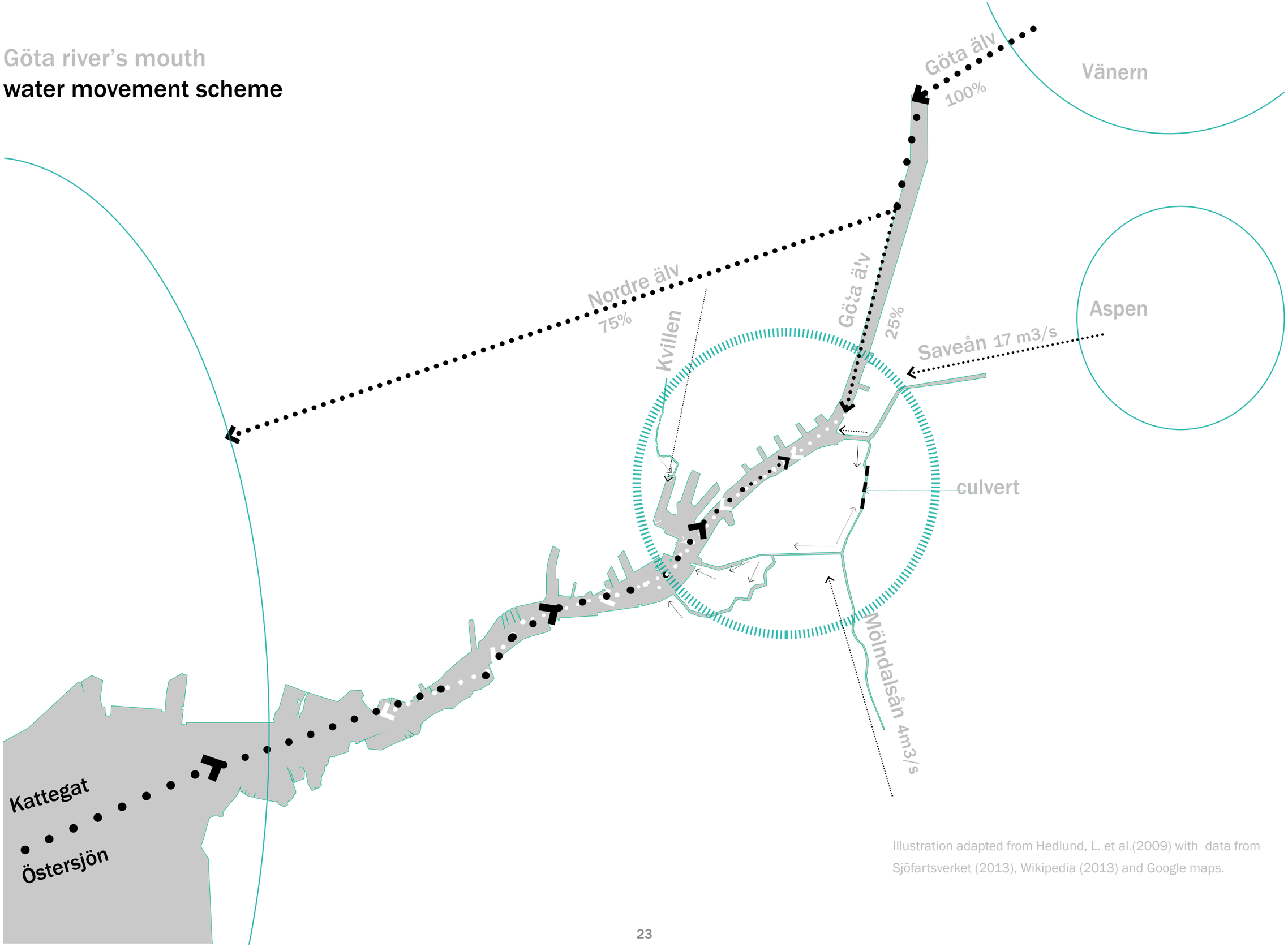
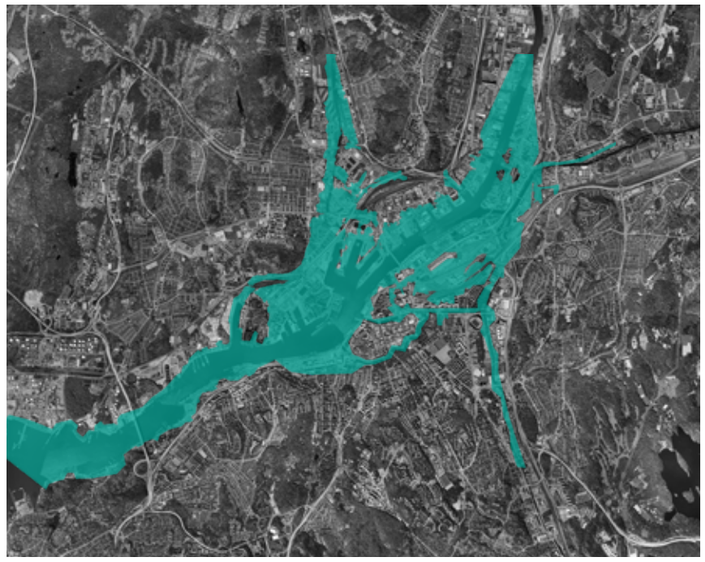


Illustration adapted from Hedlund, L. et al.(2009) with data from Sjöfartsverket (2013), Wikipedia (2013) and Google maps.

sea level rise

today +0.1

future 1 scenario +1.1

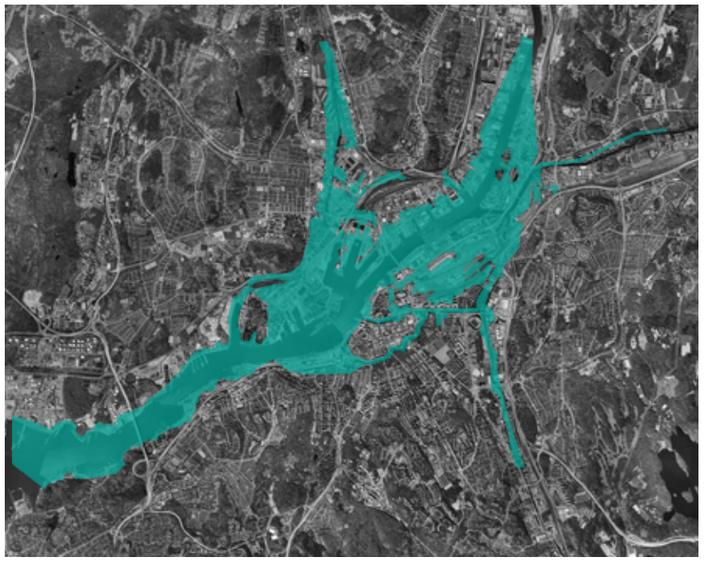


future 2 scenario +2.1

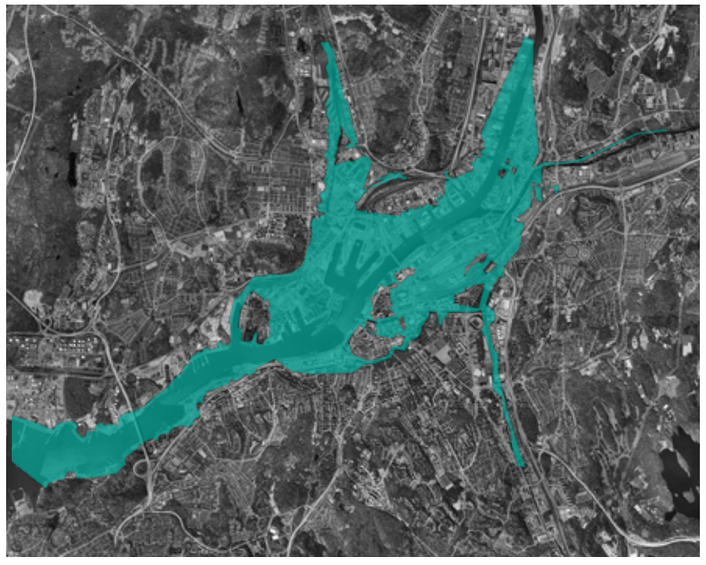
Illustration adapted from Hedlund, L. et al.(2009) with data from Göteborgs Stad (2009) b and Göteborgs Stad (2005). Background map from http://www.maps.google.se.

flood

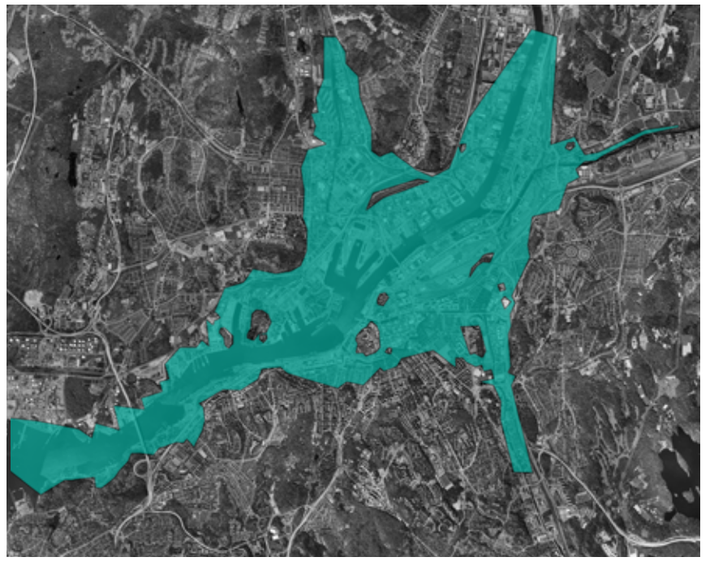
extreme weather event



today +1.8



future 1 scenario +2.8



future 2 scenario +3,8

Illustration adapted from Hedlund, L. et al.(2009) with data from Göteborgs Stad (2009) b and Göteborgs Stad (2005). Background map from http://www.maps.google.se.

this can happen by 2060

The different scenarios presented on the previous pages shows the implication of sea level rise and extreme weather events on the urban environment of Gothenburg.

The worst case scenario managed is the one revealed here where 2m of sea level rise is combined with an extreme weather event of 1.7m resulting in a level of 3.8 as the normal level of today is 0.1m.
Even though these predictions are expected by 2100 the lack of compromise of several countries in decreasing CO_2 emissions could shorten up the time line to 2060 as denounced by the Swedish minister of environment[1].

How will Gothenburg adapt to climate change? How these areas that are going to be developed will adapt to the menace flooding?

In order to further evaluate the situation of these central areas an analysis showing the different functions of the city that could be affected when an extreme weather event occurs is shown on the following page.

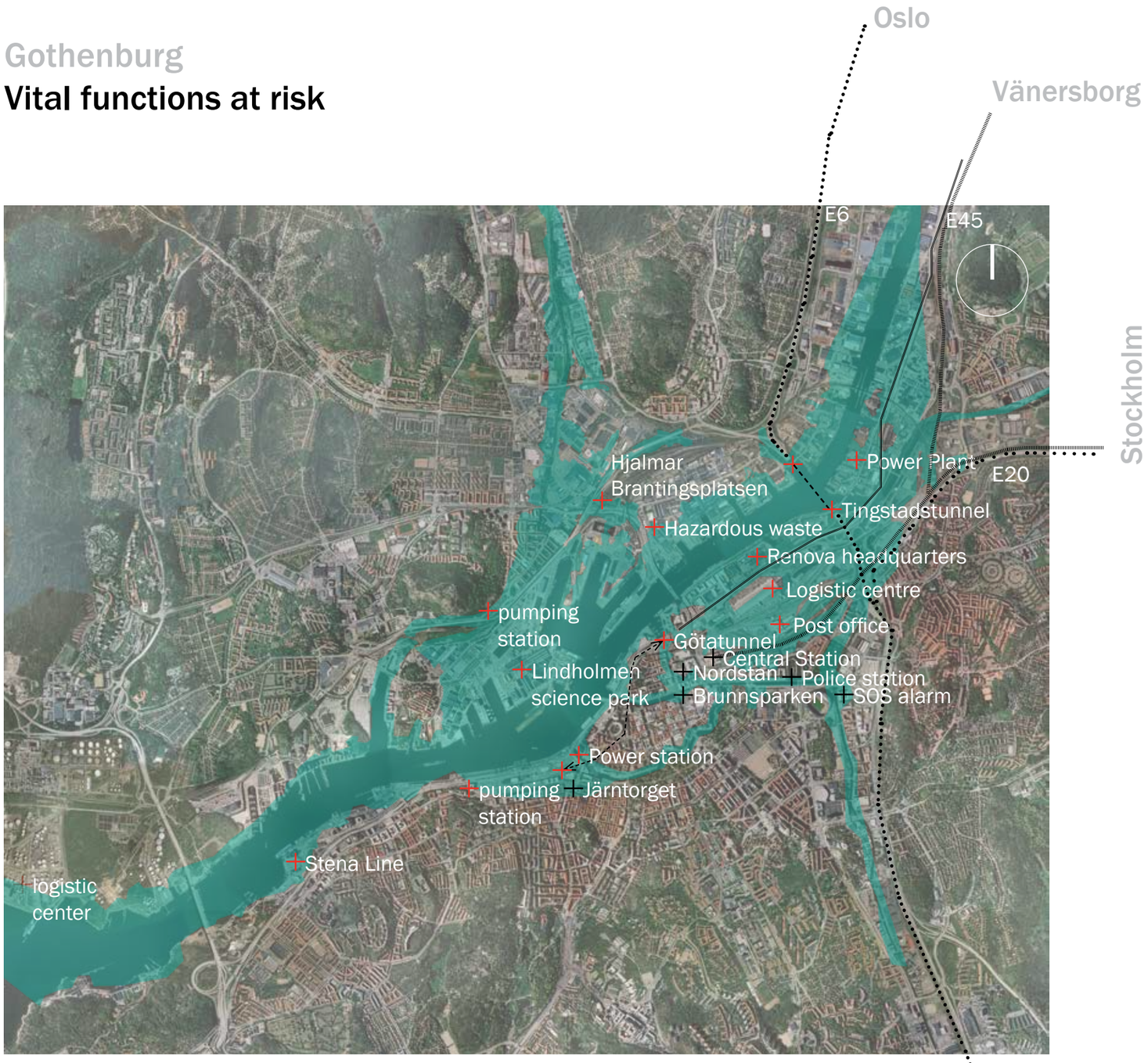
future 2 scenario +3,8

Illustration adapted from Hedlund, L. et al.(2009) with data from Göteborgs Stad (2009) b, Göteborgs Stad (2005) and Orre, S. (2012). Background map from http://www.maps.google.se.

1 Orre, S. (2012)

Gothenburg

Vital functions at risk



+ AT RISK TODAY (LEVEL +1.8)
+ AT RISK FUTURE 1 (c. LEVEL +2.8)

From the analysis one may identify different services that should be reallocated or adapted in order to assure the well functioning of the city even with high water levels.

The management plant for hazardous waste at Ring Ön supposes a great environmental risk if these residual substances are poured into the river. Simultaneously the logistic centre situated at Gullbergsvass could generate great economical losses in chain, affecting not only the functioning of Gothenburg but the whole region. Moreover, the convergence of the different high ways (E6, E45 and E20) it takes place within the Gullbergsvass area. This fact not only makes Gothenburg vulnerable from its infrastructure point of view producing a chain effect on other cities but also from a social point of view. The city center reflects one of the city's biggest problems: the inappropriate scale of its transport infrastructure generates a segregated urban environment where cars and gods are priori ti zed instead of people. It appears opportune here to cite the project of Espinàs Tarrassó from the river city workshop in which it is proposed a ring road around Gothenburg[1]. In that way the project offer a solution to avoid having these highways within the city center and decreasing the tension in case of flooding. This system is utilized by thousands of cities in the world and could be very suitable and effective for Gothenburg.

Illustration adapted from Hedlund, L. et al.(2009) with Göteborgs Stad (2009) b and Göteborgs Stad (2005). Background map from http://www.maps.google.se.

1 The Rivercity Gothenburg project group (2011)pp.24.

Gothenburg

Proposal Future Barriers

The municipality of Gothenburg has been looking at the issue for a long period of time but especially after the storm of Gudrun and the high water levels of February 2008 which affected large parts of the city's central areas.

Two pathways has been discussed in order to prevent the city from flooding. The first one consists of three barriers in order to achieve a stable water level inside the city. Both permanent and movable barriers have been studied being the former already discarded.
Movable barriers demands a large area to dispose the barrier when open as well as it demands greater stability of the land for its safe construction and operation. Therefore the possibility of using this complex flood control system is not clear yet as the soil stability at Jordfall is supposed to be not optimal. Besides from an environmental point of view, being the area protected by Natura 2000, it is up to the European commission to evaluate possible impacts and make the decision to allow or not such barrier.
Moreover by putting up barriers the problem will be moved to other cities upstream affecting in this case Kungälv because the water would have to take other trajectories in order to discharge.

The second alternative being discussed is the construction of walls along the river to prevent water to flood the city.

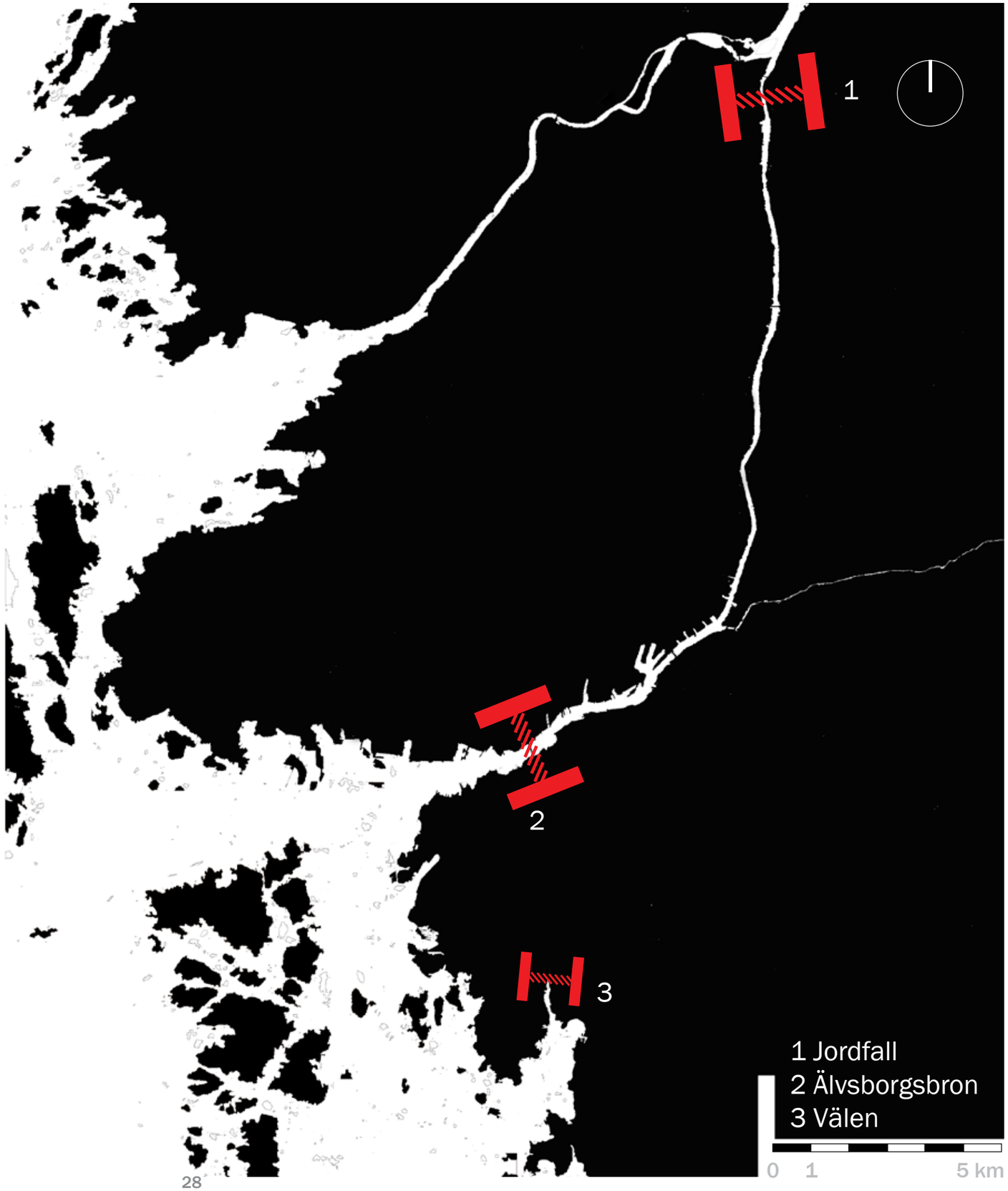
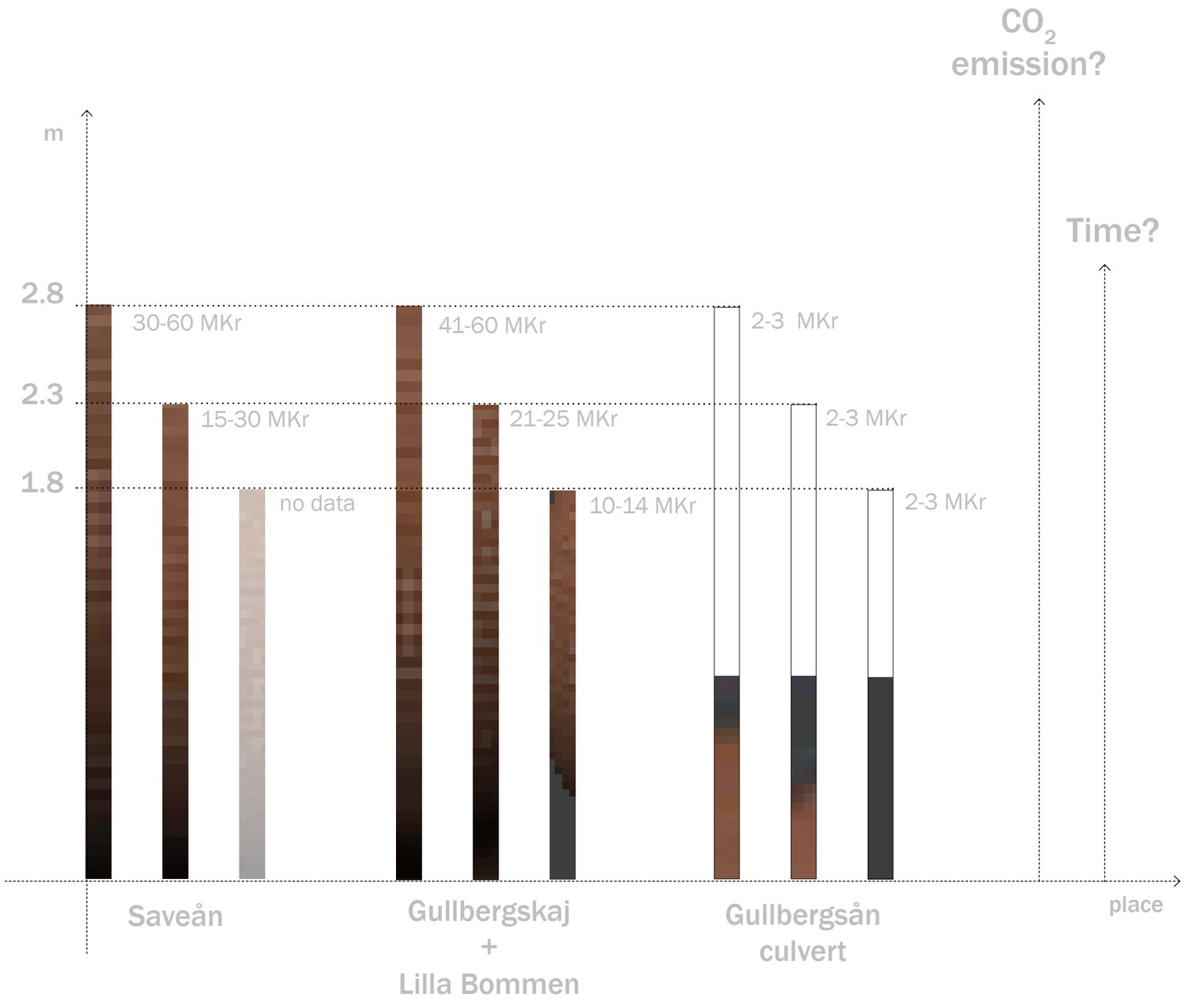


Illustration adapted from Qviberg, S.(2009) with data from Göteborgs Stad (2009) b. Background map from http://www.maps.google.se.

Gothenburg
Cost of quay wall



A wall to prevent water coming into the city, an ancient technique, have not only the obvious issue of destroying the natural relationship between river and land but it also implies extraordinary budgets.

Likewise both the building of walls and the erection of barriers are time and money consuming and it is not mentioned in the analysis of any of them the energy consumption and therefore the CO_2 emissions that will come along with any of these.

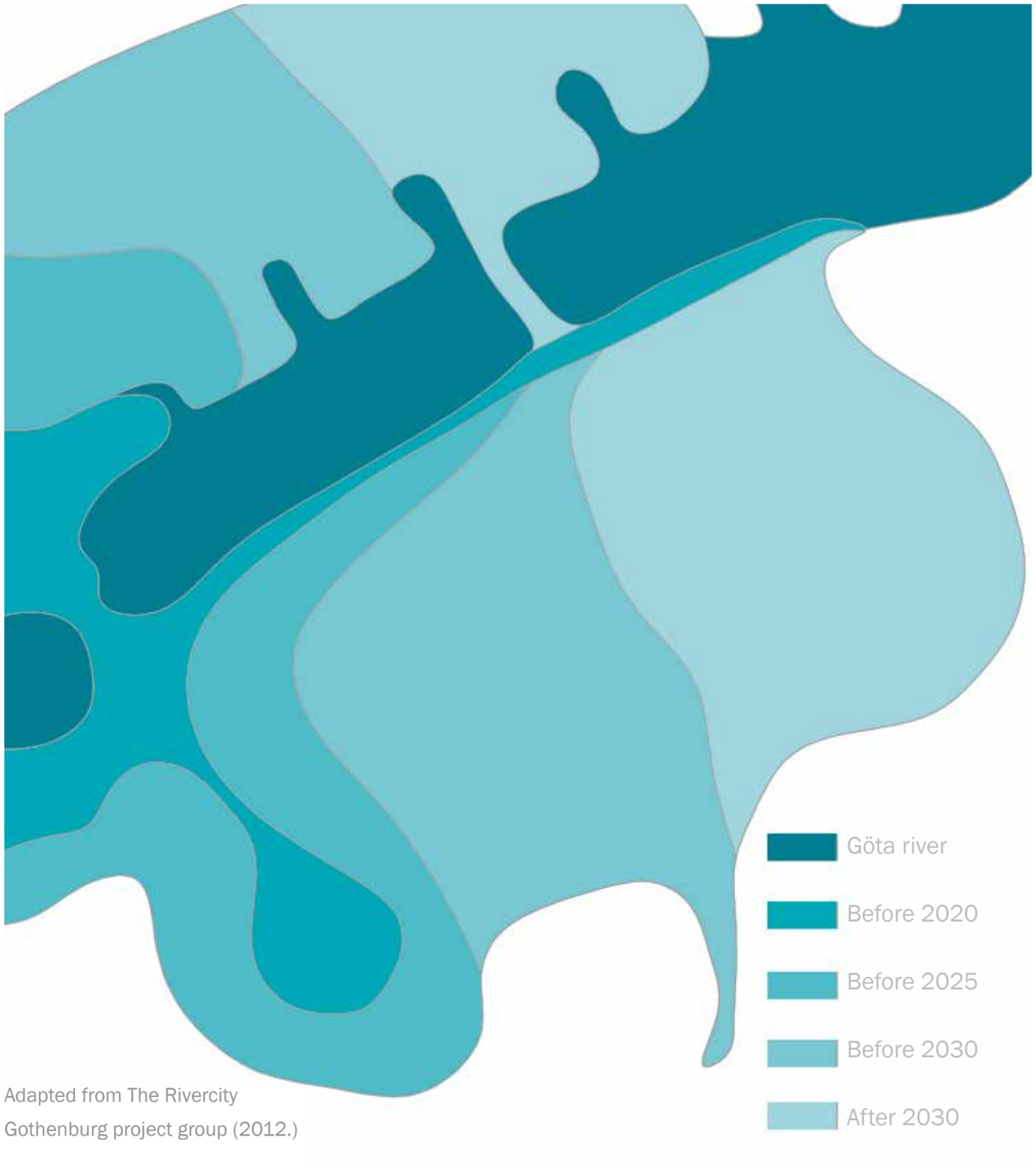
Illustration with data from Göteborgs Stad (2009) b

Gullbergsvass
development time line

What is going to happen with Gullbergsvass and the central renewal areas?
For the municipality Gullbergsvass is still a question mark, the area does not have a strong urban tissue where to start from, its complex transport infrastructure and the flooding issue that still no one does know how to deal with is challenging the planning and time is passing.
Though, there is a time line for its development. The area, as shown on the image, is supposed to be developed from the centre towards the east.
It appears contradictory to begin the planning of a district highly vulnerable to floods without having a clear strategy for dealing with the issue.

?

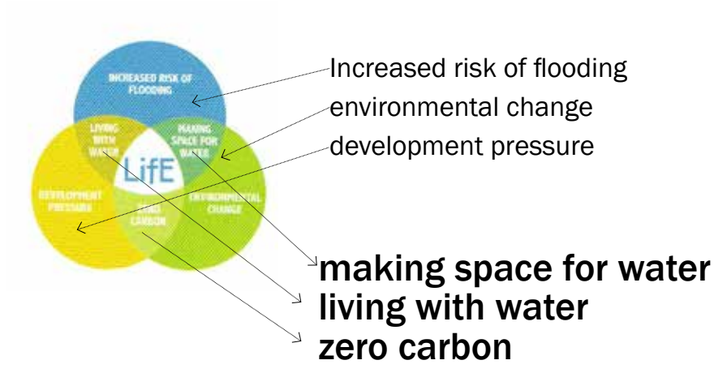
The development of Gullbergsvass is still a question mark for the planing office of Gothenburg.[1]



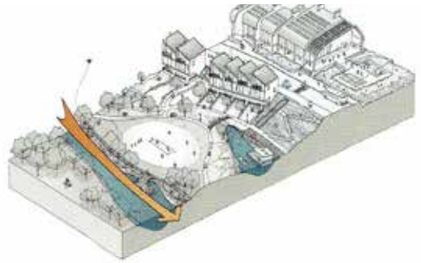
Adapted from The Rivercity
Gothenburg project group (2012.)

1 Verbal Interview with Anna Jarkiewicz, Stadsbyggnadskontoret, 21-03-2013

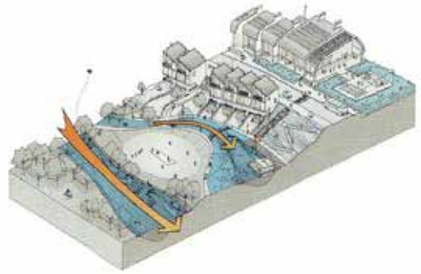
life project UK



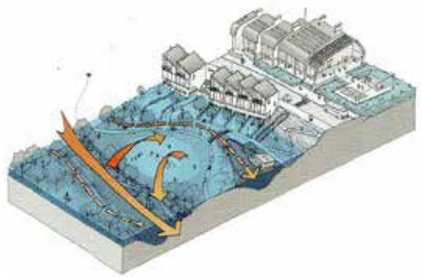
The area corespondent to 1/100 year storm will be with the impact of climate as big as the area for 1/1000 years storm.



Every day



1/20 years storm



1/100 years storm

Water takes place on recreation spaces, all buildings are constructed on flood free zones.

All images were scanned from Topos European Magazine N°68 (2009).

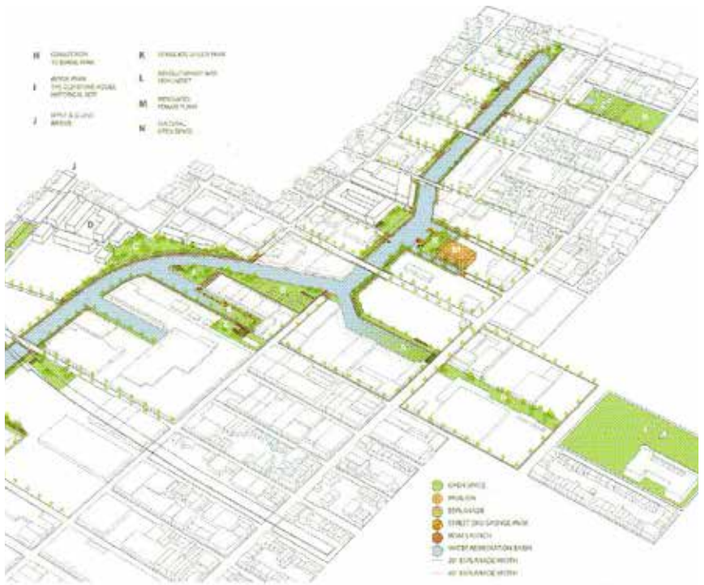
As a method this thesis utilized literature review in order to explore how different cities and countries are today trying to manage the flooding problematic. Different examples are therefore presented here.

The life project established three different strategies to cope with the flooding issue in the UK: making space for the water, living with water and zero carbon. These strategies aim to respond to an increased risk of flooding due to climate change and the development pressure on flood plains.

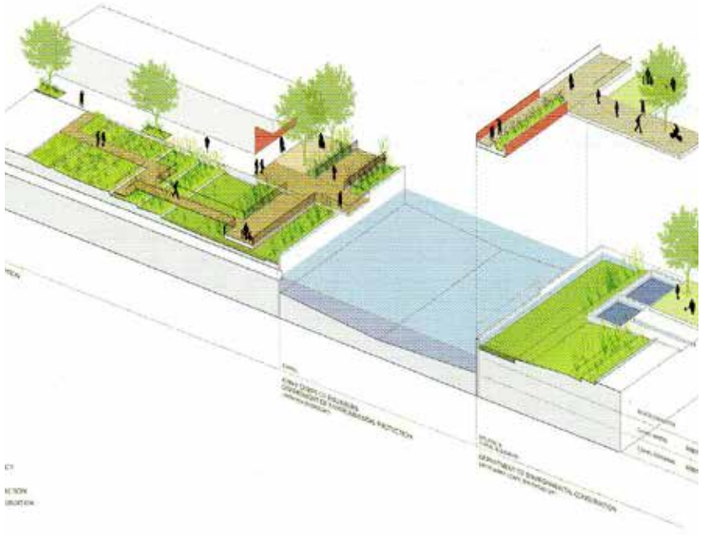
The project accepts the likelihood of climate change and acknowledge the need to adapt to live with water. Therefore making space for water would enable urban environments to receive the flood in planned spaces, avoiding to locate any vital functions there. This strategy reduce the reliance on defences allowing the river or the sea to take place when needed. The last strategy, zero carbon, makes reference to a locally based green energy production intending to produce their own energy and thus reducing its carbon footprint.[1]

1 Barker, R. and Coutts, R. (2009)

sponge park New York



Flexible storm water management



The park cleans up the water and provides a better access for the public

The second reference is the Sponge park in New York . This project is about revitalizing the edge of the canal in order to improve its access to people and to clean the water way. An amelioration of the green area along the canal is proposed with elevated pathways enabling people to make use of it even when flooded. At the same time this green edge composed by 2,2 hectares of wetlands slows, filters and clean storm water before it reaches the canal.[1] One of the tools used by the designers (dlandstudio) was to analyse the historical development of the canal by overlapping maps from different periods.

Similar to the “Life” project in the UK, the next example is the Netherlands “make room for the river” project. Being under sea level the country has generated land out of water with a complex system of dikes and dams in order to keep water out of the settlements.
This has been done for many years but the pressure of climate change has provoked the need of adaptation in terms of space planning. Understanding that in the future the country will not be able to produce enough amount of energy to feed all pumps to keep water out they decided as well as the UK to provide space for the water.
Six diagrams called “space makers” illustrates the strategies to increase safety while living with water: dike relocation, flood bypasses, lowering flood plains, green rivers, lowering the groynes and removing obstacles.[2]

The Netherlands: make room for the river

System of Dikes

Space makers & ways to increase safety

All images were scanned from Topos European Magazine N°68 (2009).

1 Drake, S.C and Kim, Y.K. (2009)
2 Sijmons, D. (2009)

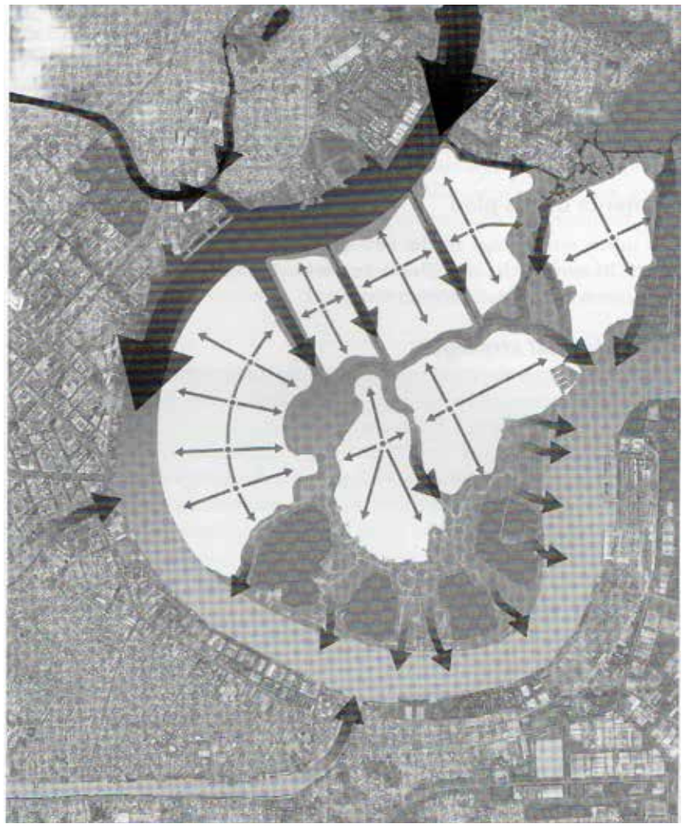
Thu Thiem, Ho Chi Minh City

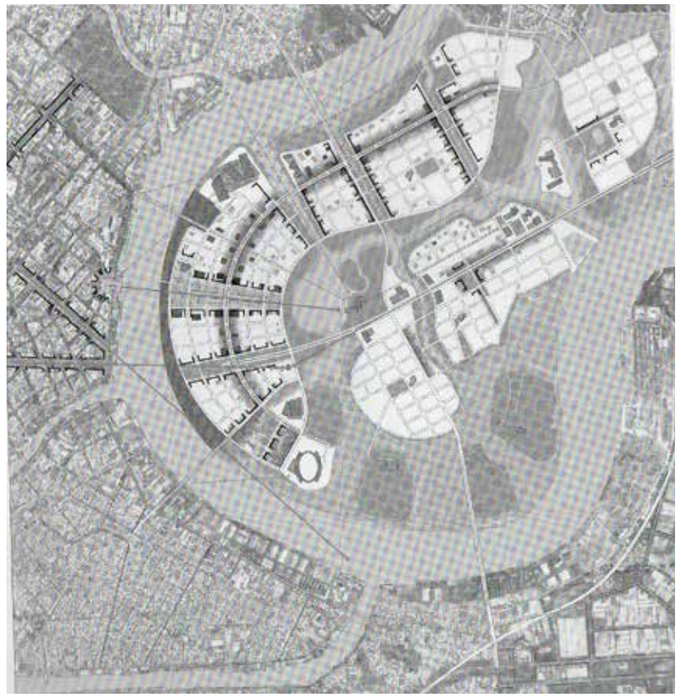
This project by Sasaki comprehends a new city district in Ho Chi Minh City, Vietnam.

The peninsula formerly used for cultivation of rice due to regular flooding intends to respond to the demand of a growing population decreasing the pressure on the historic city.

The project proposes a broad serie of channels and wetlands to manage the flow of water and to fill the northern part in order to accommodate an urban mix including housing , offices, commercial and cultural places as wells as institutional.[1]

Despite much soil is going to be moved around to generate the northern part and thus the cost of the project and its CO_2 emission will be high the proposal appears as a good example of sustainable development because of its ecological strategy including in the planning 31 per-cent of green areas from which 12,5 per-cent is proposed to be park and 18,5 wetlands.





The images were scanned from Charlesworth, E. and Adams, R. (2011)

1 Pieprz, D. (2011)

Cuba urban agriculture

The next example is about Cuba and urban agriculture. The documentary explains the success of a strong community showing how a complex issue such as the lack of oil provoked a change in people's mind set and how this was beneficial to the community itself.

Cuba suffered a free fall of the economy with the collapse of the Soviet Union, furthermore blocked economically by USA , the island, went through the so called special period 1989-1993. The unavailability of oil shook the country, the lack of energy led to daily blackouts, long waiting hours for a saturated public transportation, and severe shortage of food. The country was isolated, everything had to be produced, solved within its frontiers.

Agriculture was the sector most affected, being on the way to the green revolution which implied a fossil fuel dependent practice, was suddenly frozen. Out of fuel to feed its machinery and fertilizers to grow with, people started to farm in the city. Every abandoned spot was used to grow food, cooperatives were started to buy supplies and many people changed profession to farmer.

Urban agriculture provided people with food without the need of transportation. Kiosks selling fruits and vegetables were strategically located through out the city. 140.000 new jobs were created and centers for perm a culture were initiated to provide education for better practices. Research institutes commenced to investigate in organic practices. Today bio-pesticides and bio-fertilizers are exported to other countries.

“the power of community”

How Cuba Survived Peak Oil by Faith Morgan

Contrary to what happens usually when a country goes through a economical crisis Cuban health flourished. The consumption of a more varied quantity of vegetables and fruits and the use of bicycle and walking for transportation reduced the cases of diabetes, heart attacks and strokes.

Today 80 % of the agriculture in Cuba is organic. 50 % of the vegetables and fruits consumed in Havana are produced there and in smaller towns 80 to 100 are grown within the city.

The thesis presents this example in order to show how different lifestyles are possible, in this case by necessity, people adapted to the scarcity of oil.
Climate change is demanding the reduction of emissions of CO_2 therefore a reduction of consumption of oil is needed. Urban agriculture not only provides with fresh fruits and vegetables but certainly reduces the need of transportation thus reducing the climate impact.
Cuba sets an example showing how they manage to live without or with very little oil focusing on urban agriculture and the power of community.

study visit

Augustenborg-Malmö

Photos: Tomé, 2013.

Study visits were also a method utilized in this work, the first one presented here is the visit to Augustenborg. This area was formerly well known as a socially problematic neighbourhood due to high unemployment rates and rapid turnover tenancies. Simultaneously the area was regularly affected by floods.

In 1998 the city of Malmö launched Augustenborg Eco-city project. This one aimed a social, economic and environmental sustainable neighbourhood. One of the project many assets was the participative design for the new outdoor areas as part of the new system for storm water management. Some of the project's achievements are described as follows:

_ Three new companies have started from the process
_90% of the area's storm water is managed by green roofs, open channels, ponds and wetlands
_Turn over tenancy has decreased with 20%
_ Biodiversity increased with 50%
_Unemployment rate decreased 8%(1997-2007)[12]

1 Malmö Stad
2 Rollfsdotter-Jansson, C.

Västra Hamnen-Malmö

With the successful experience of Augustenborg Malmö city took the opportunity to master this technique when developing the new district of Västra Hamnen (the west harbour). The project includes a vast framework of open channels, swales and ponds for the management of storm water meanwhile providing the district with different aesthetically qualities.
The water flows through the system allowing evapotranspiration and absorption by different plants, the rest finds place at ponds where ducks and other animals move about.
This framework not only helps to decrease the pressure on the draining systems but also enhances the biodiversity of the area.

Photos: Tomé, 2013.

Gothenburg

historical development

1809

1855

1900

Illustration with data from Historical Maps of Gothenburg.

historical development

reduced river course

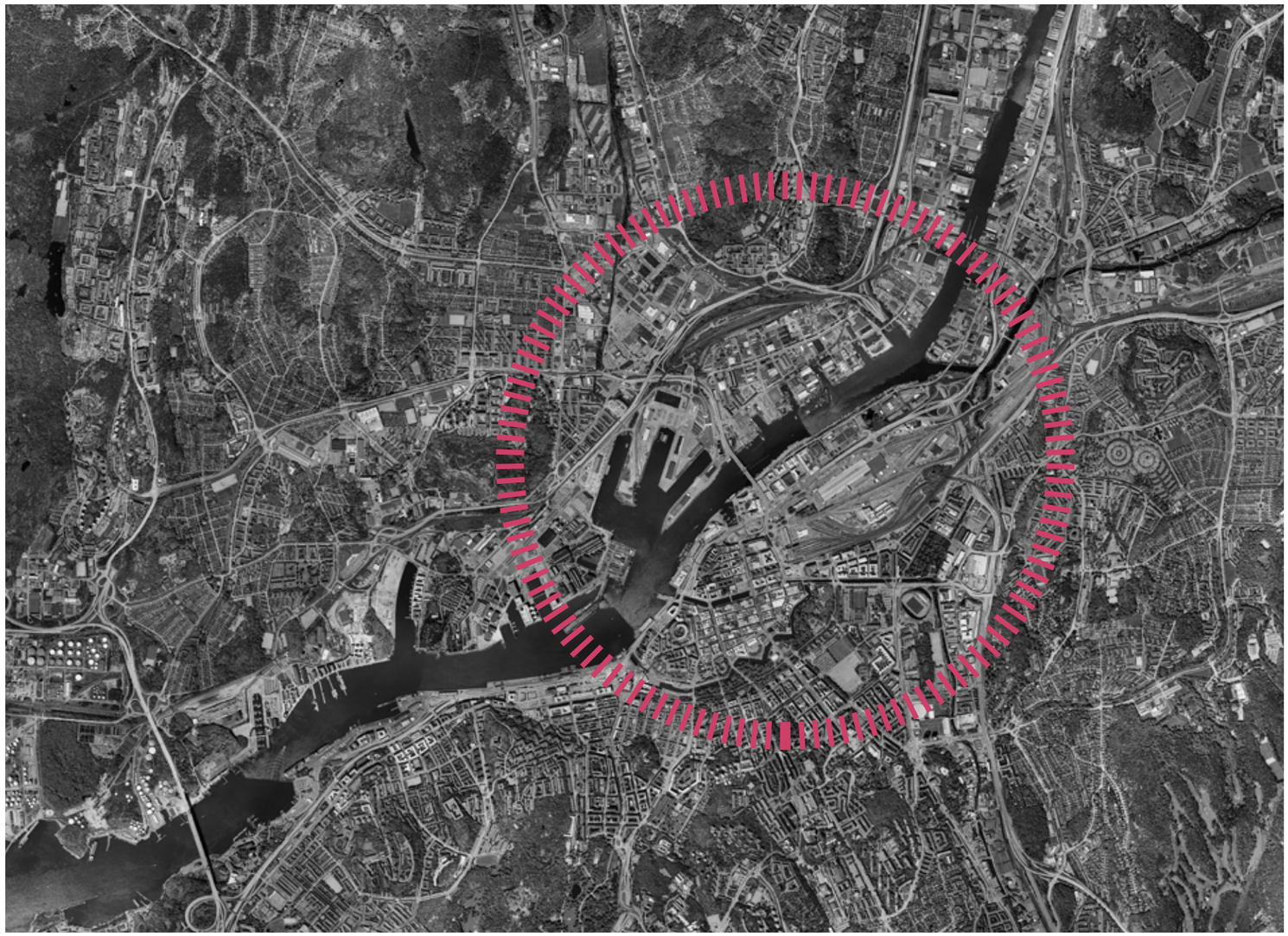
Analysing the historical development of Gothenburg one may observe a variation of the Göta river boundaries.

The reduction of Göta river's course has allowed urbanization where once upon a time was a wetland, as well as, it enhanced navigation for the transportation of goods by the straightening of its banks.

These facts are noticed in several cities all around the world where an increased development pattern along coastal areas disables their natural resilience. Likewise the transformation of rivers courses, the sediment starvation by the construction of dams and other flood control systems are anthropogenic factors that increases the inability of deltas to cope with floods.[1]

The filling of wetlands was also a world wide trend in the past being considered dirty places where diseases flourished. Moreover these areas represented barriers within the city scape for displacements.[2]

It is not before the 70's decade with the Ramsar Convention, an international environmental treaty signed 1971[3], that these places were acknowledged as valuable ecosystems to be conserved.



Background map from http://www.maps.google.se.

2013

1 IPCC (2007) c

2 Pollak, L. (2007)

3 Convention on Wetlands of International Importance especially as Waterfowl Habitat. (1971)

Gothenburg
geology map

From the geology map over the area one note that the reduction has been done by land filling over clay soil. This was done firstly with dredged material from the river and from the city's own waste. Consecutive filling continued until 1985 and it is today not sure what all these fillings consist of. Several chemicals and dangerous waste are supposed to be buried there producing a higher risk if these areas get flooded as those could be transported by the water. [12]

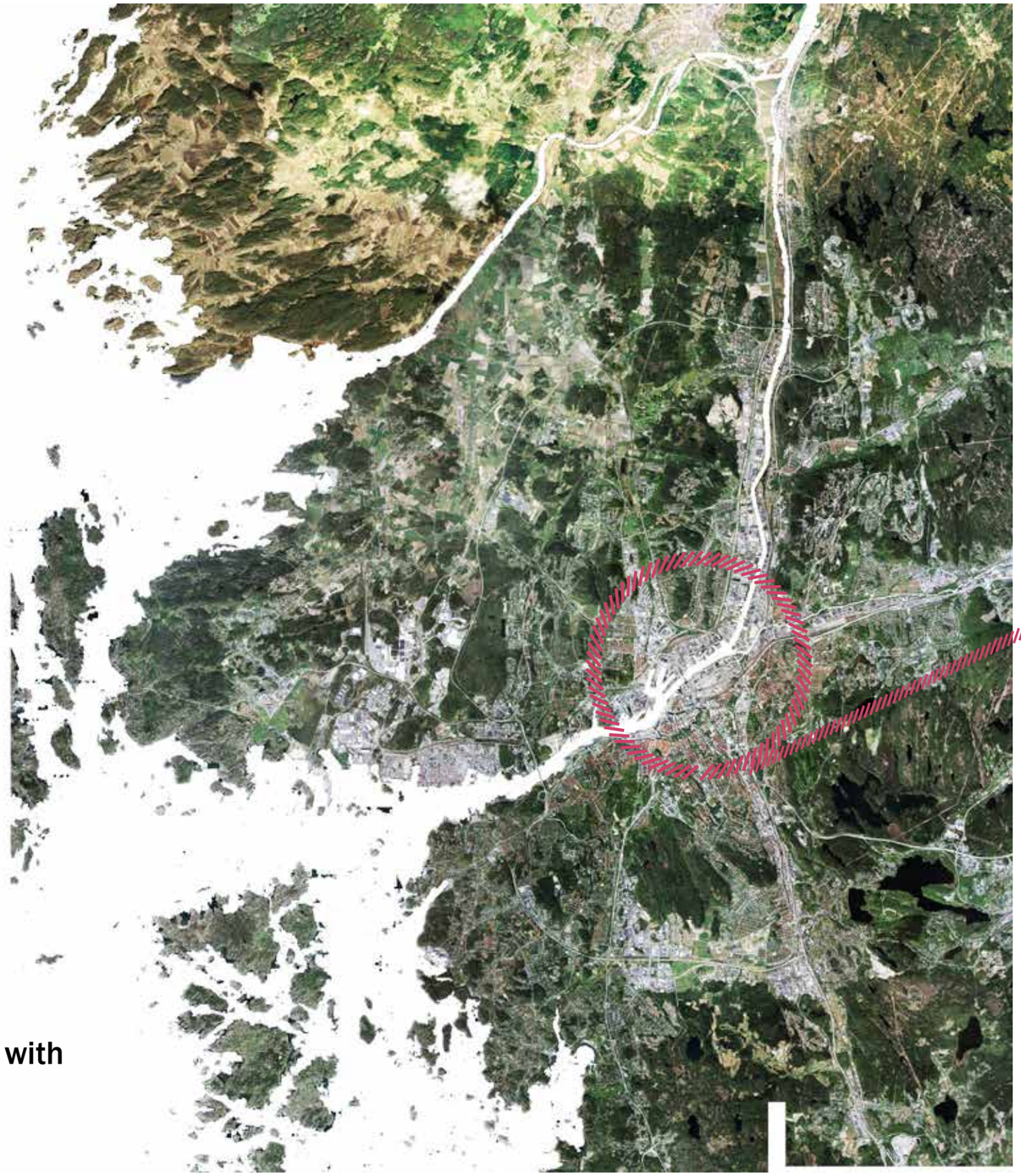
On the next page it is shown how this area is covered by an impermeable layer of concrete substituting the long green valleys suggested on the landscape characterization of a municipality publication. These valleys are not more than concrete valleys where water has no place to go leading to recurrent floods even with low precipitations.

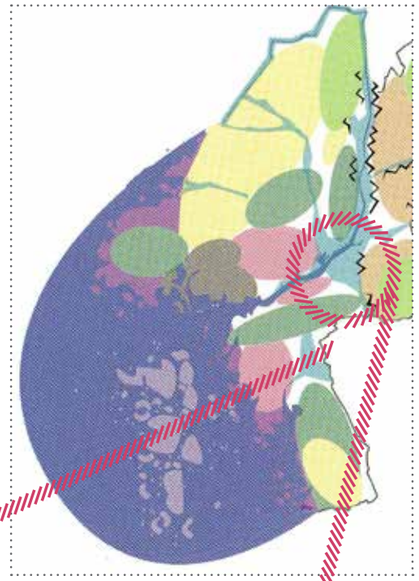
Illustration adapted from Göteborgs Stad (2000)

1 Göteborgs Stad (2009) b
2 Sweco Environment AB (2011)

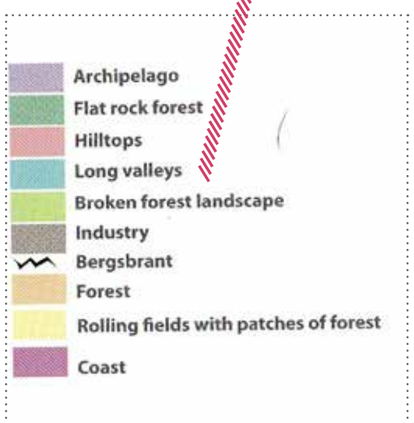
Gothenburg

concrete valleys





The image above and below were scanned from Göteborgs Stad (2007). Map from http://www.maps.google.se.

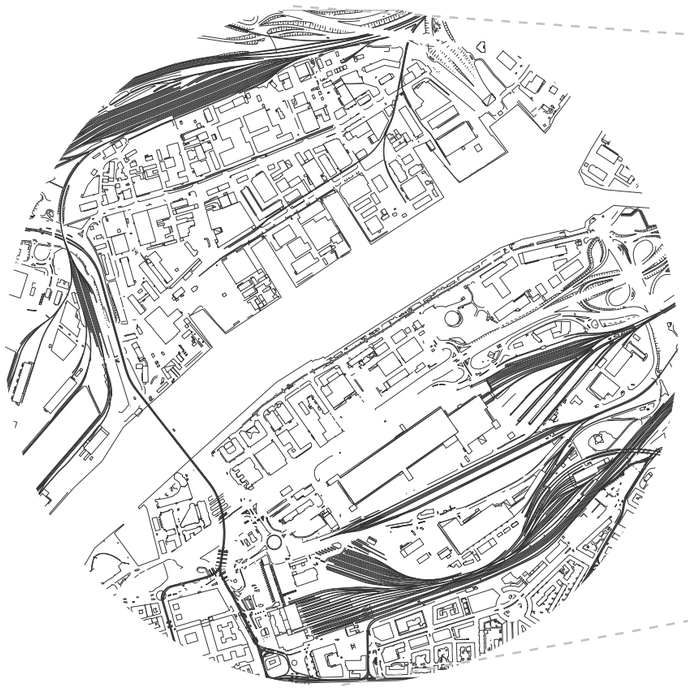


waterfront areas with no porosity

0 1 5 km

along the river
industrial areas

The sealing of the surfaces along the waterfront can be explained by the examination of the functions that takes place there. Not surprisingly associated to the river most of these areas accommodate industrial facilities.



The industrial processes has been associated with the river because of logistic planing but also it has implied a large interconnected terrestrial system (railway and motorways) dissociating the river from the city.

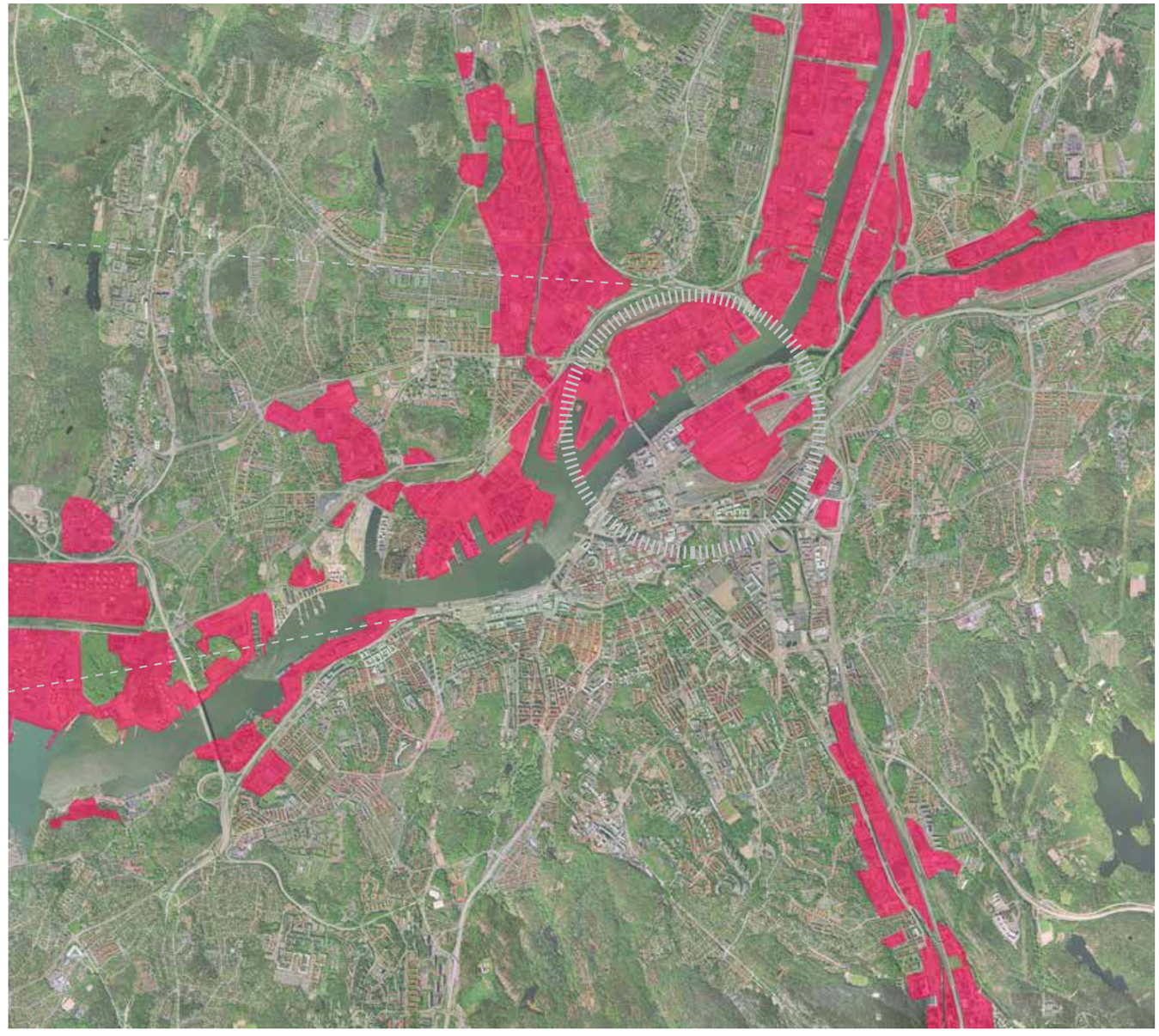


Illustration: background map from http://www.maps.google.se

regional strategy

wetlands restoration

Agreeing with Hedlund, L. et al. (2009) this thesis proposes as a regional strategy to restore the wetlands along Göta river, in order to provide the river with spaces to be flooded in case of storm.

This measurement would enable the cities along the river to control floods as wetlands functions like a sponge absorbing and delaying the water which otherwise flows quickly eroding river banks and flooding urban environments. By providing the city with a time frame, the lost of lives and the degradation of important infrastructure will be avoided.

Wetlands are to be restored following their natural pattern, using curves which are more effective to slow down the speed of the water flow but also because the shape allows sedimentation and results easier for its remotion and the maintenance of the wetland itself.

Wetlands besides of decreasing the velocity of the water flow thus preventing landslides along the catchment area have a key role purifying the water, furthermore they provide housing for different animals and plants enhancing the biodiversity of the water way.

Wetlands: decreases water velocity, river bank erosion, prevent landslides, absorbs water, allows evapotranspiration, enhances biodiversity!

absorb and delay water

The urban strategy proposed by this study is to improve the porosity of all industrial areas along the river.
The sealing of the surfaces with an impermeable layer of concrete has decreased their natural resilience disabling the surfaces to absorb water.

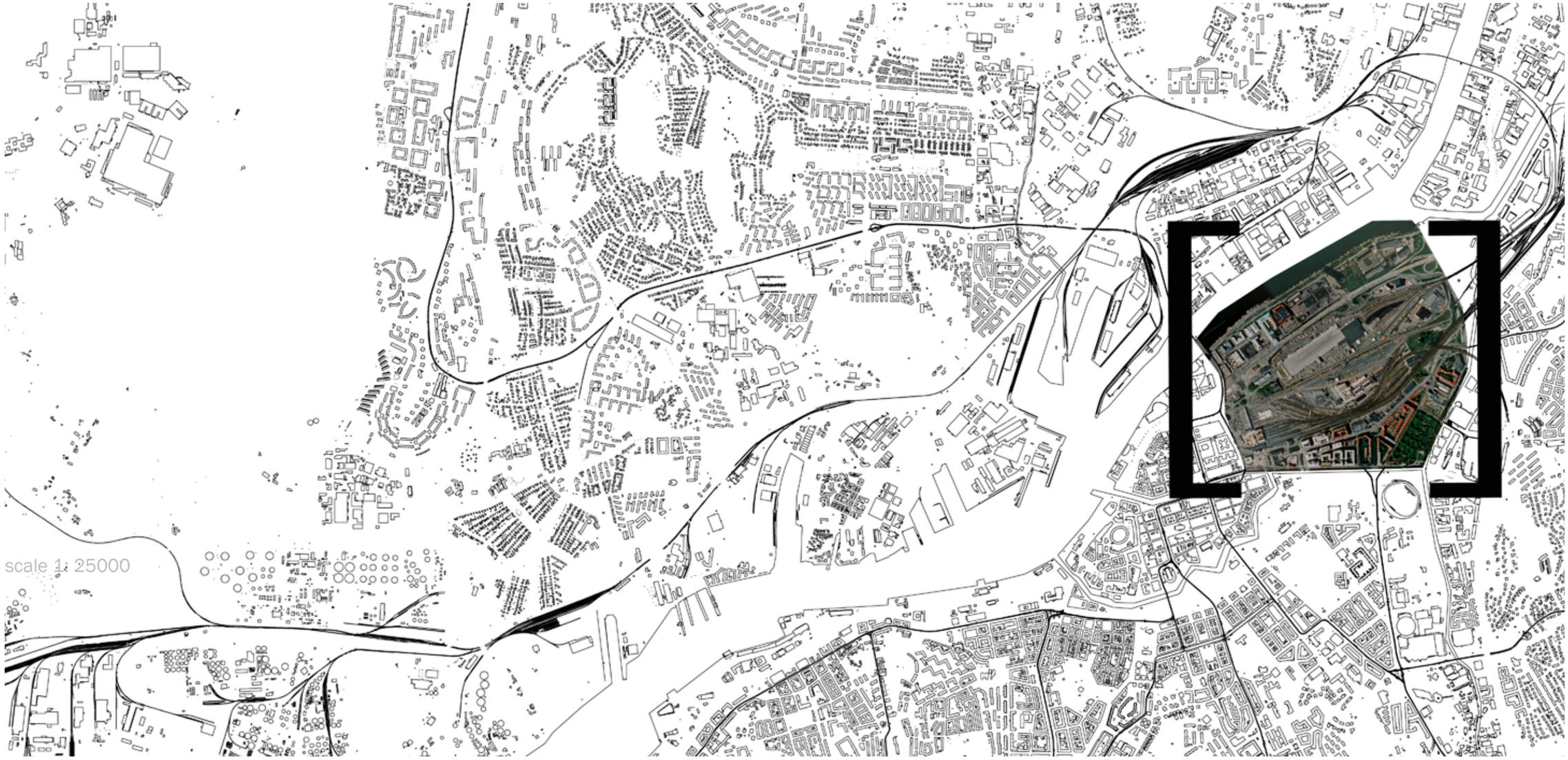
From the analysis of the substrates one recognized that under this impermeable layer of concrete lays the river bed with a predominance of clay soil. This soil type has the characteristic of being impermeable because of the structure of its particles.
To increase the porosity of such implies to work with the green factor in order to improve the soil's capability of absorption. Therefore the strategy comprehends the use of rain water gardens, wetlands, green roofs, vegetated swales and other vegetation in order to decrease the pressure on the drainage system. These alternatives are to absorb and delay the water as well as enables its evapotranspiration by the vegetated surfaces.

Increase porosity of industrial areas where possible

Illustration: background map from http://www.maps.google.se

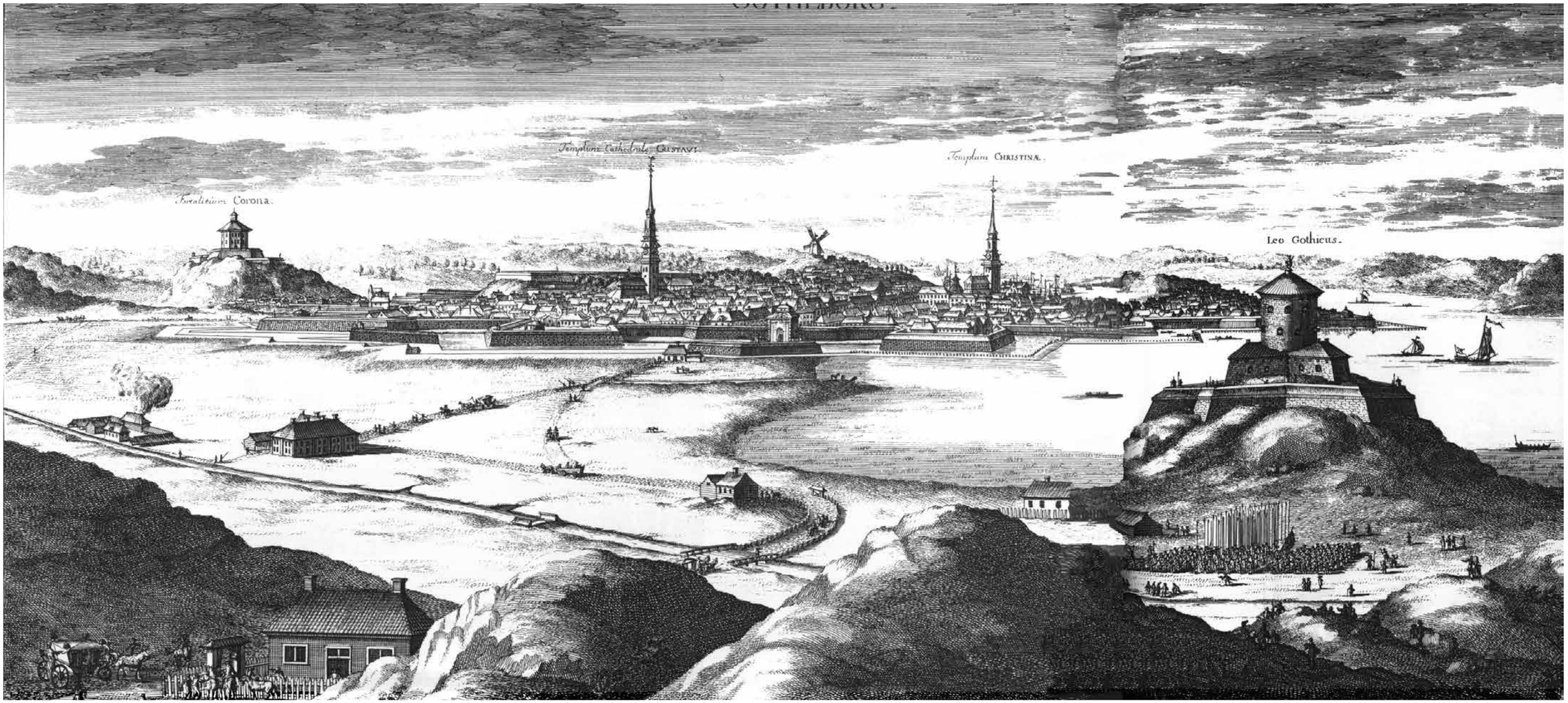
Gullbergsvass

no vass* left



Gullbergsvass, the area utilized as a test bed, used to be a wetland (see next page). Named after this quality as *vass** means reed in Swedish, a characteristic plant for this type of ecosystem.

illustration Suecia Antiqua



Erik Dahlbergh: c1700

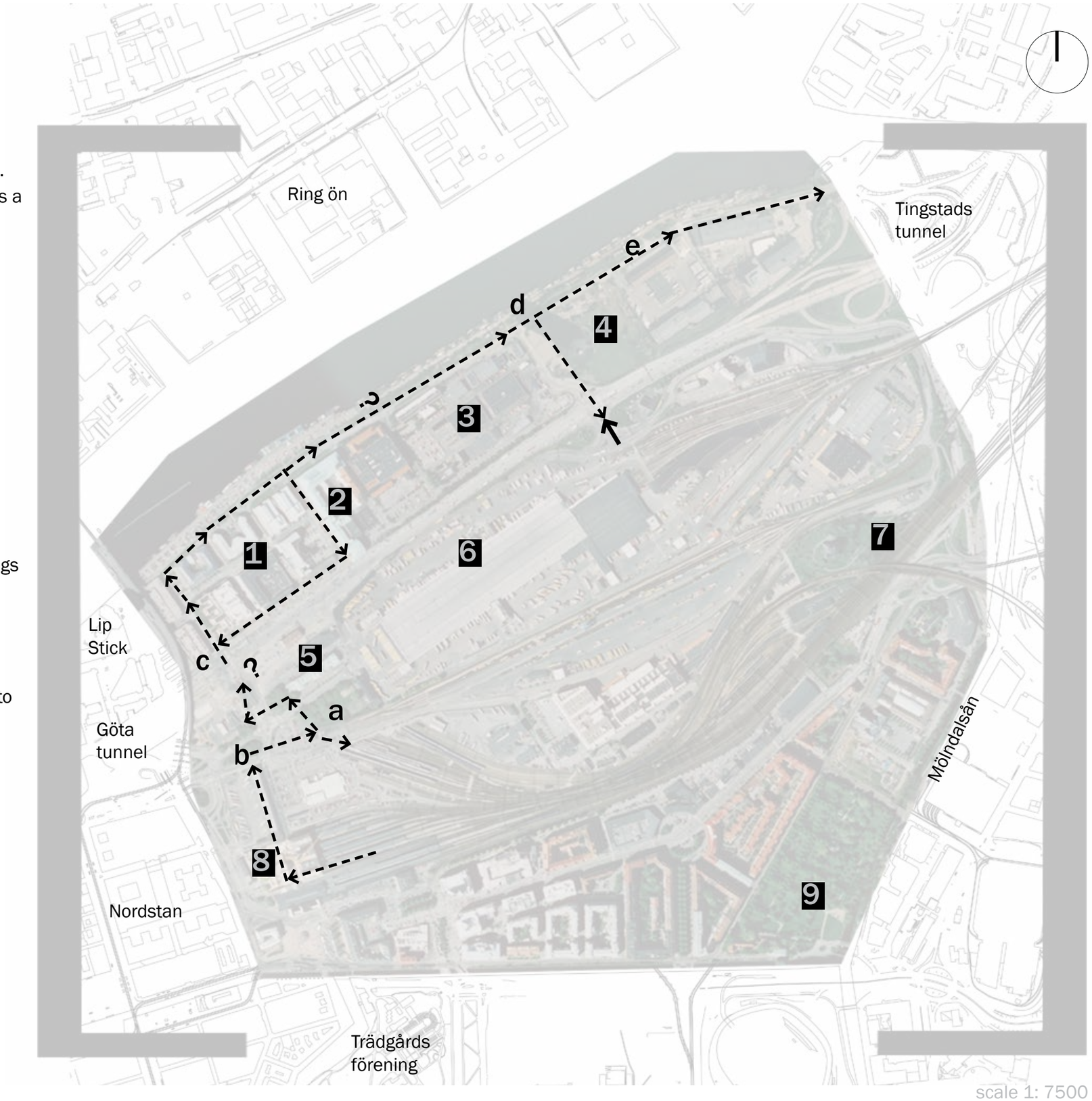
Gullbergsvass
presentation of the area

Here is presented the result of the field studies realized. The area correspondent with the number one possesses a clear tissue where urban qualities are recognized.

1. Offices
2. Pagoden
3. Renova headquarters
4. The Gasometer
5. Old station
6. Logistic centre
7. Skansen Lejonet
8. Central Station
9. Cementery

Number two, four, five and seven corresponds to buildings which have architectural qualities that this study aims to conserve aiming to enhance the cultural heritage of Gothenburg and envisaging them as identity drivers for the future development of the site.
Number six, the logistic centre, is connected by railway to the port receiving containers that are later transported by trucks and vice versa, configuring the scale of the transport infrastructure of the site.

– – → Walking route 1
a,b,c Pictures, see next page
? Surprise
→ No pass, confusing



scale 1: 7500

a

b

c

d

e

Gullbergsvass

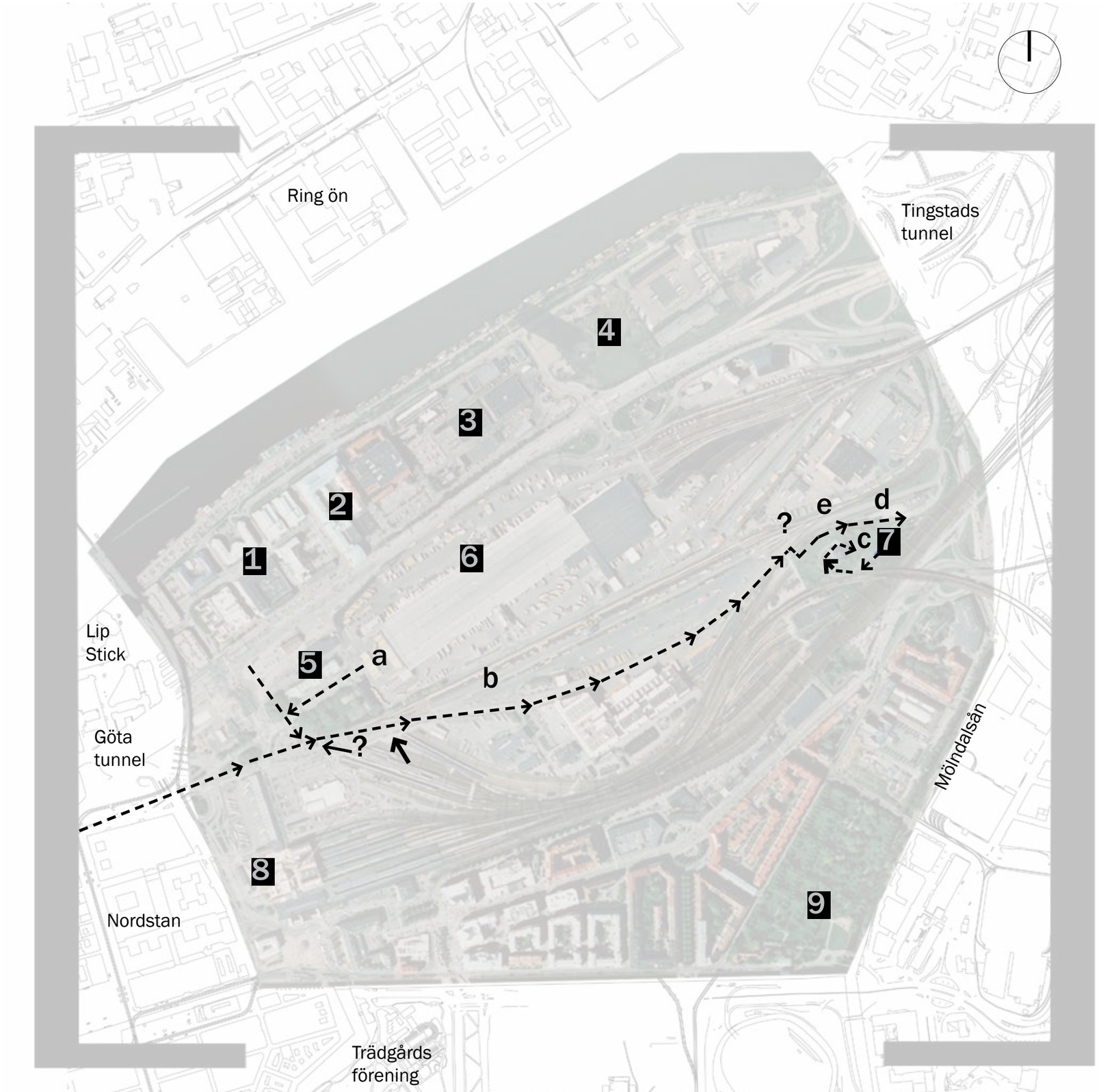
presentation of the area

Skansen lejonet, the pearl of the area, is very difficult to reach by walking as well as the river edge because of the logistic centre.

1. Offices
2. Pagoden
3. Renova headquarters
4. The Gasometer
5. Old station
6. Logistic centre
7. Skansen Lejonet
8. Central Station
9. Cementery

Number eight the central station conceived as a landmark also generates together with the logistic centre a discontinuity on the site not allowing transversal movements. Number nine, the cemetery, is the only green area within the site.
The Göta and Tingstads tunnels gets flooded with moderate rains not allowing traffic to operate properly.

– – → Walking route 2
a,b,c Pictures, see next page
? Surprise
→ No pass, confusing



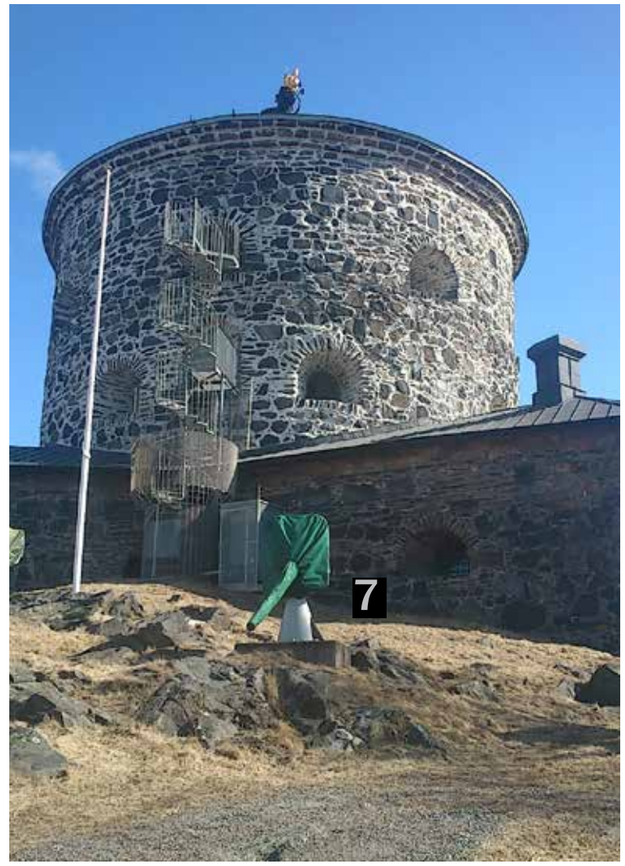
scale 1: 7500

a

b

d

c

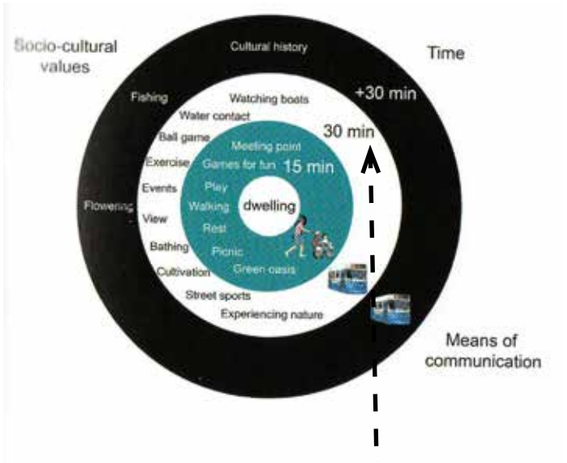


e

Gullbergsvass

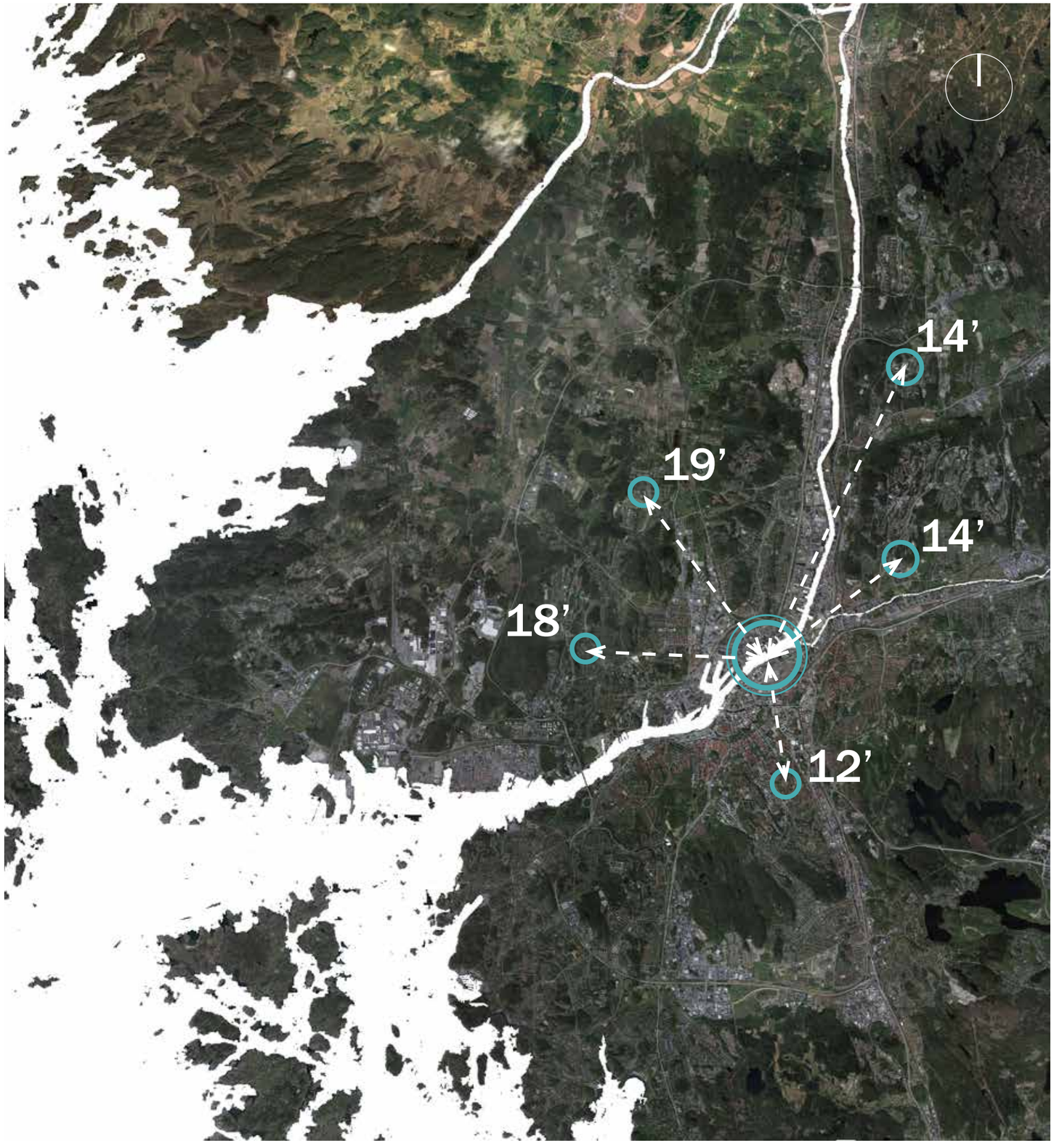
Göteborg’s heart

Gullbergsvass has a very interesting quality: its location. The area can be conceived as the heart of Gothenburg which could be taken into advantage from a social point of view. Fairly accessible by public transportation from the most segregated neighbourhoods of Gothenburg and tightly connected to the “formal” city, Gullbergsvass, could be developed in order to enhance social inclusion.



≈ 15’

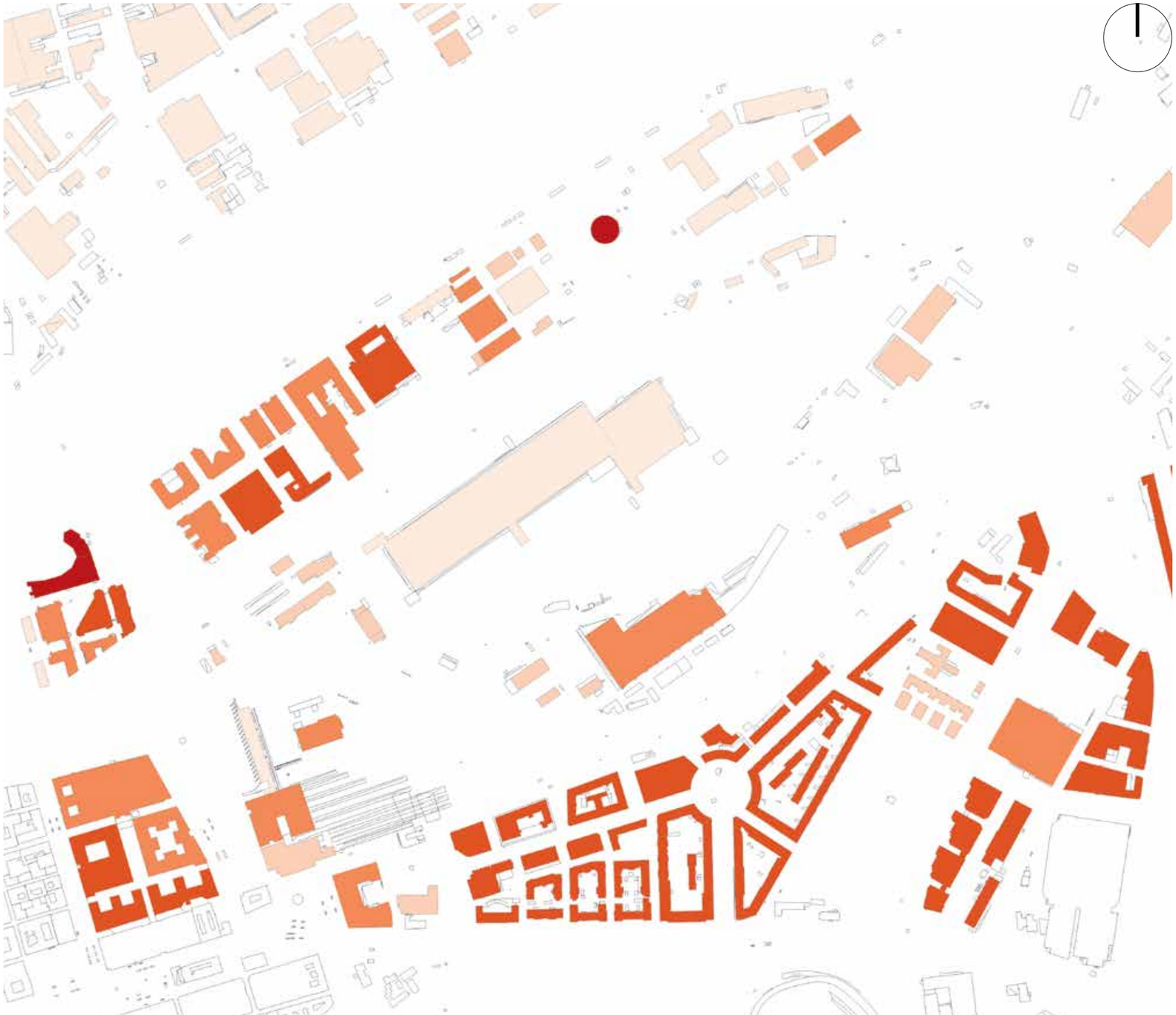
social inclusion



The image above was scanned from Göteborgs Stad (2007).
Illustration: background map from http://www.maps.google.se

Gullbergsvass

building mass



r+1

r+2

r+4

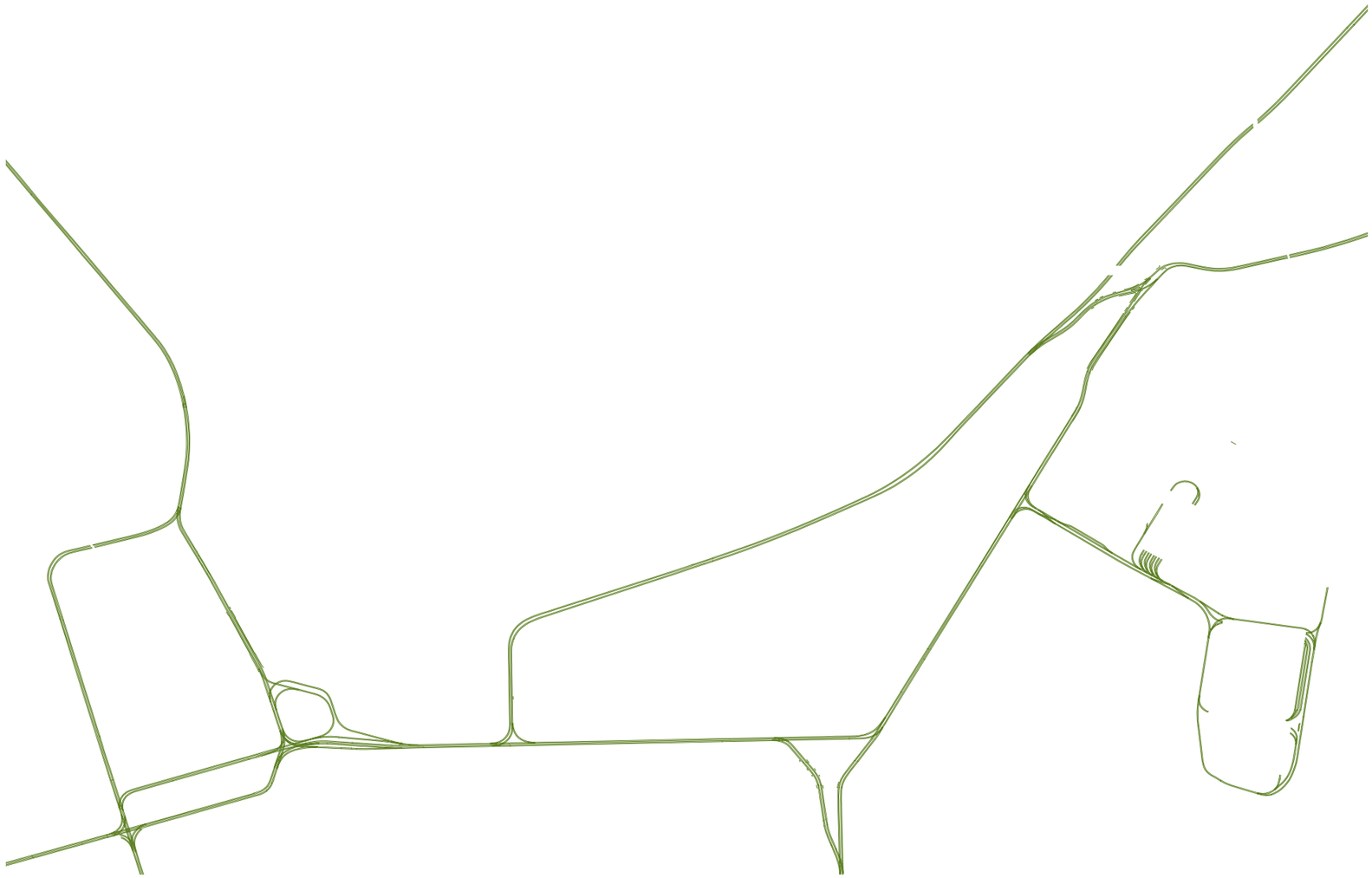
r+5

>r+10

r= entrance floor

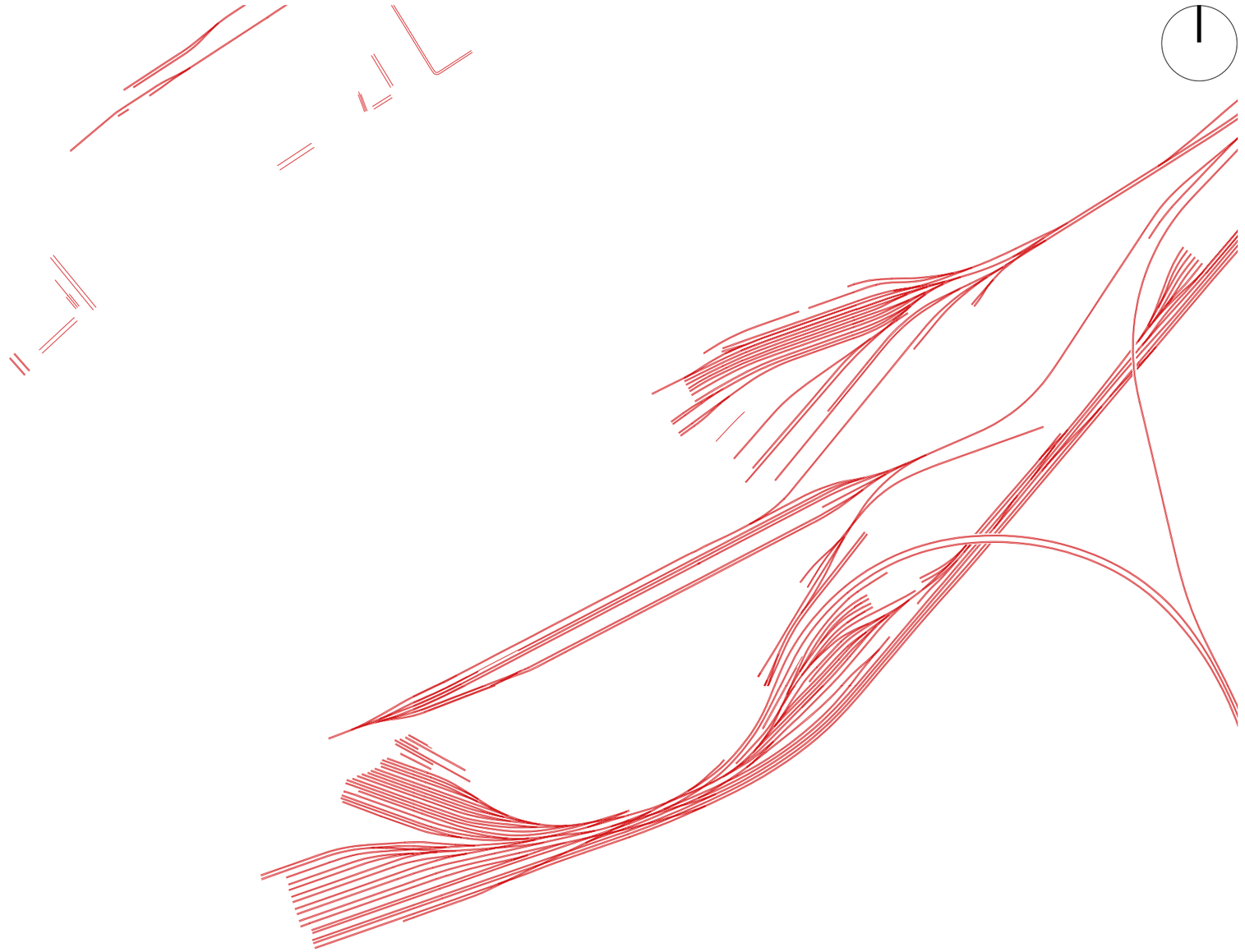
Gullbergsvass

tram line



Gullbergsvass

railway tracks



Gullbergsvass
habitats

Nature like park

Cemetery

Birds nesting

Animal and plant species with biological value

Special ecological sensitive area for animals/plants

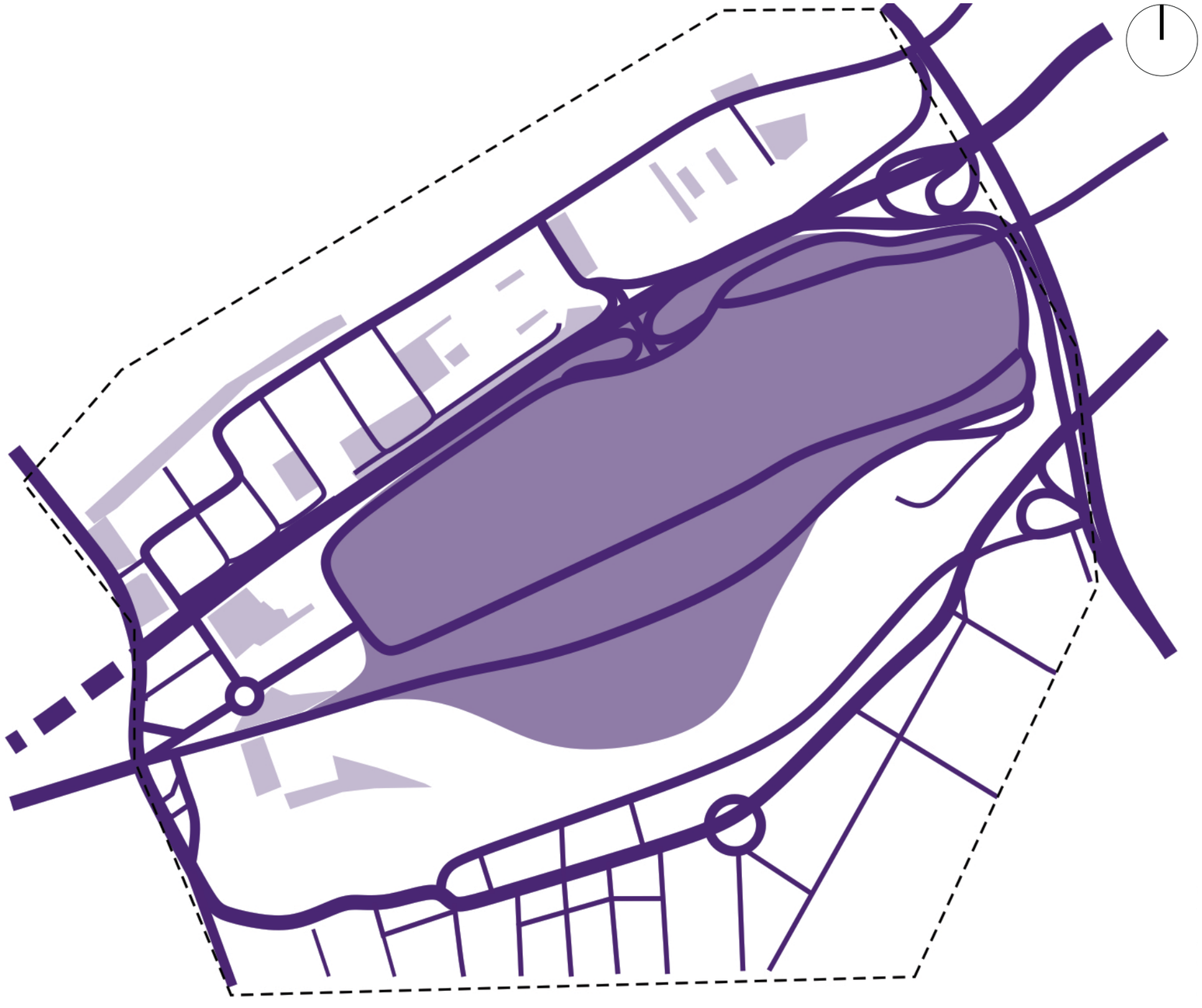
“Nice” park

Unstable ledge

Adapted from Göteborgs Stad (20012) with Verbal interview with Anna-Karin Sintorn, Landscape architect, Göteborgs Stad, Park- och Naturförvaltningen, 08-01-2013.

Gullbergsvass

circulation



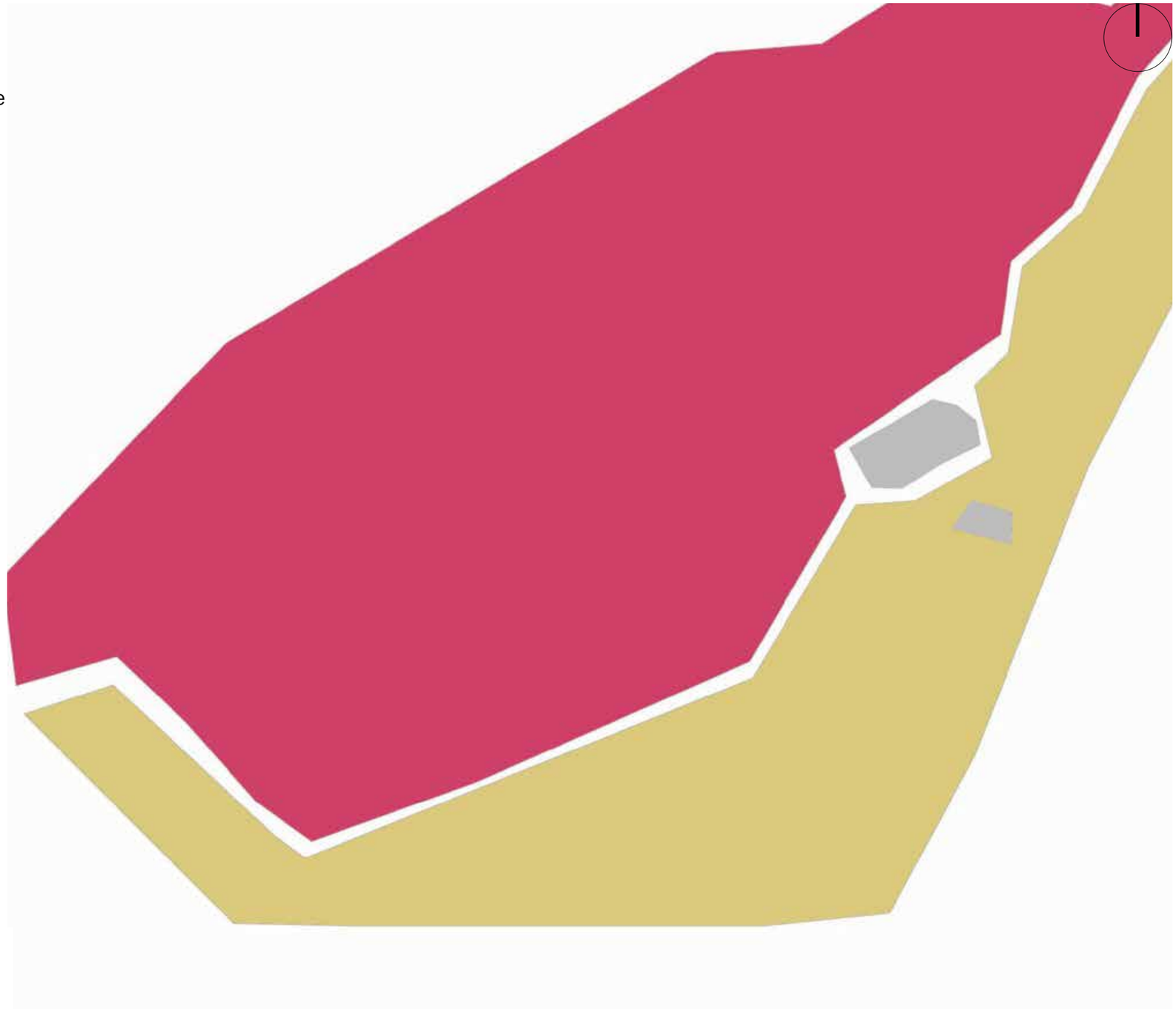
street/avenue/highway

logistic/heavy traffic

parking

Gullbergsvass
geology map

The development of Gullbergsvass supposes a large investment due to the still unknown toxicity of its in filled land. In order to develop this area it is needed to clean the soil to allow people to live there, the usual measurement is to remove the soil and transport it somewhere else and put new clean soil instead. This mechanism can be very costly and unsustainable, it implies high energy consumption for the soil remotion and transportation and transfers the problem to other locality.



predominance of bed rock

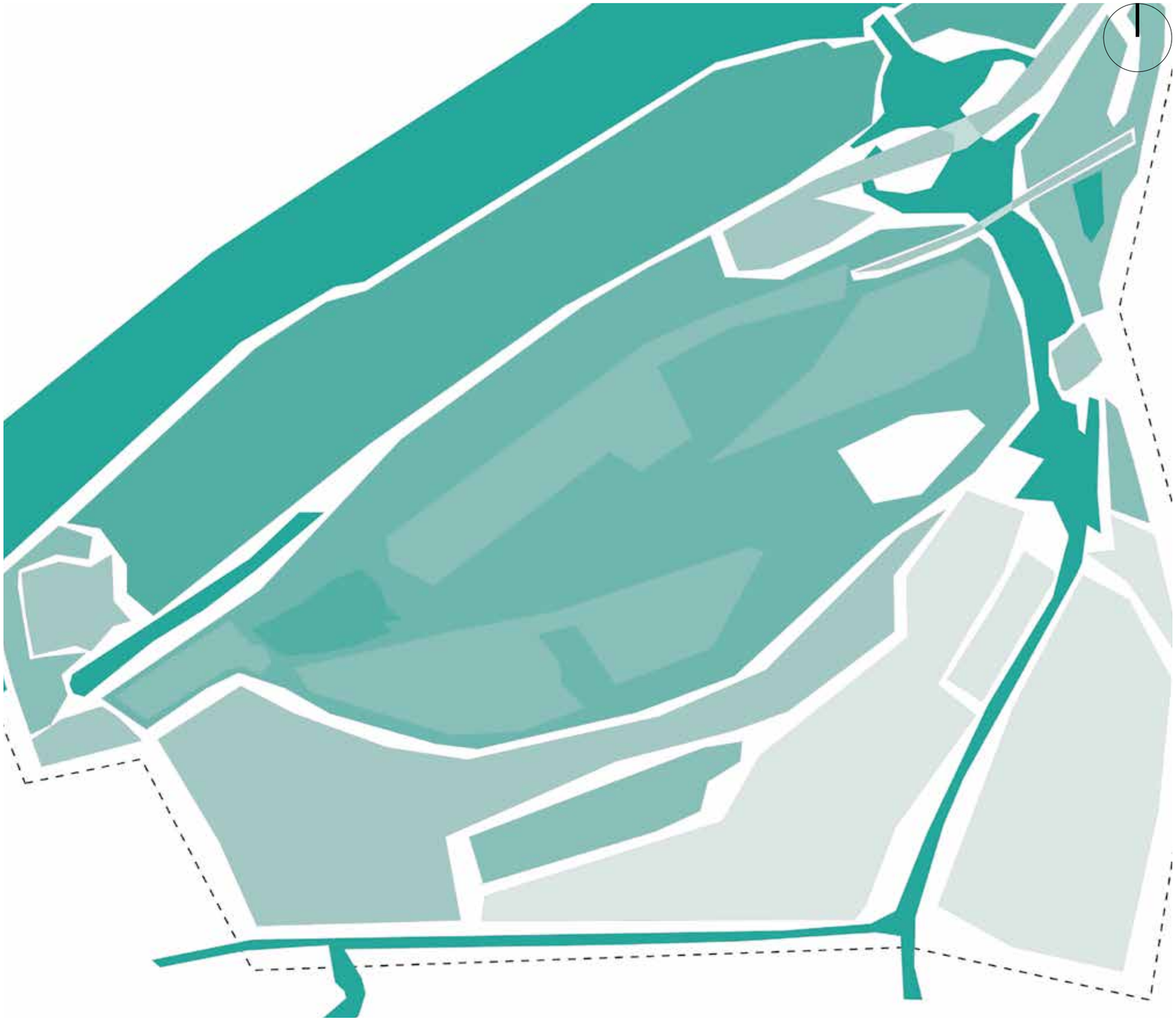
predominance of clay

landfill

Illustration adapted from Göteborgs Stad (2000)

Gullbergsvass

topography

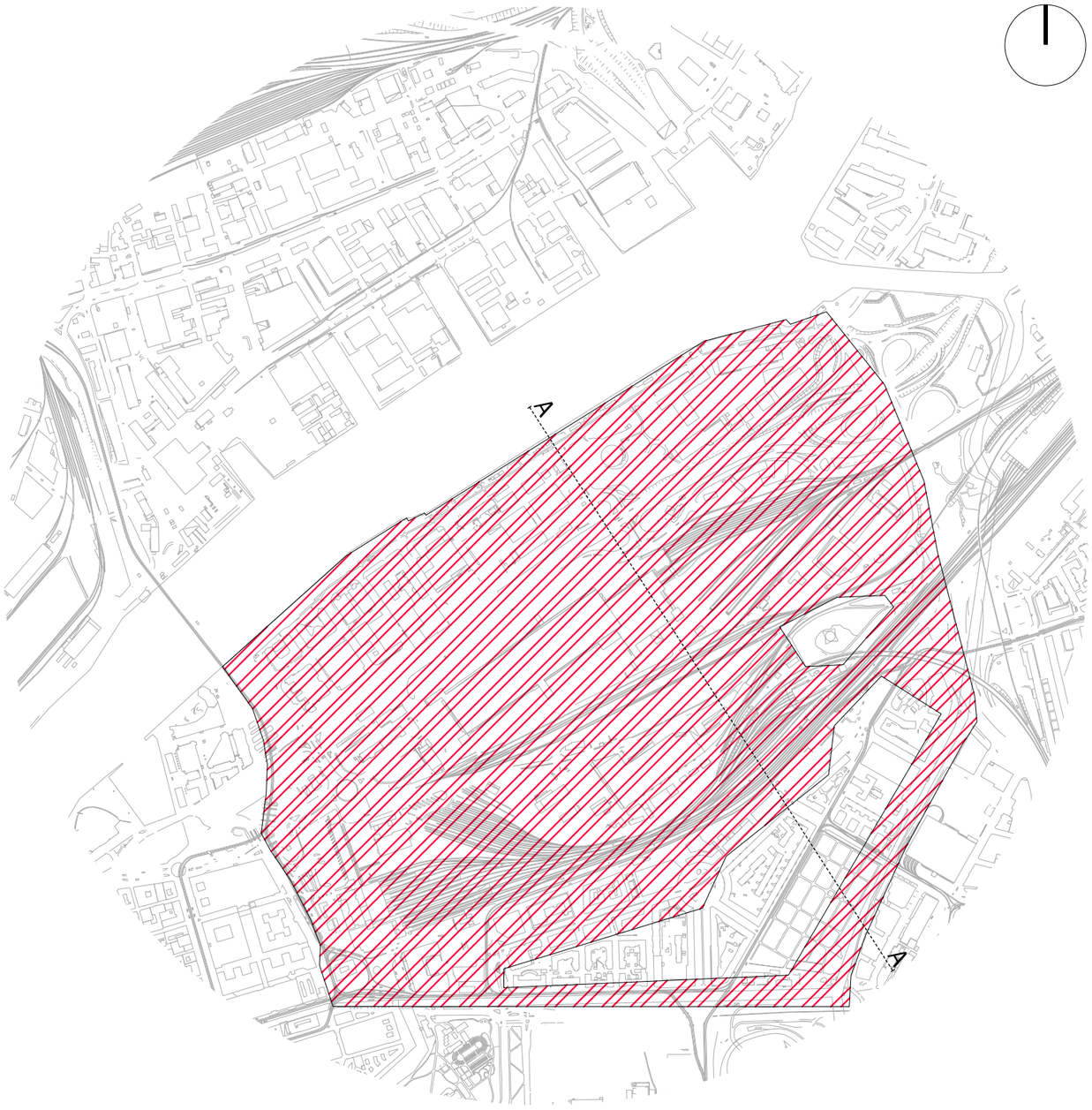


-6,0
+1,5
+1,8
+2,3
+2,8
+3,2

Adapted from Göteborgs Stad (2008)

Gullbergsvass

a red zone



scale 1: 10.000

According to the regional authority **nothing** in Gothenburg **should be built under** the level **+2.9.**[1]

Furthermore the European Environmental Agency claims that the optimal solution to adapt to floods is to avoid building in flood prone areas.[2]

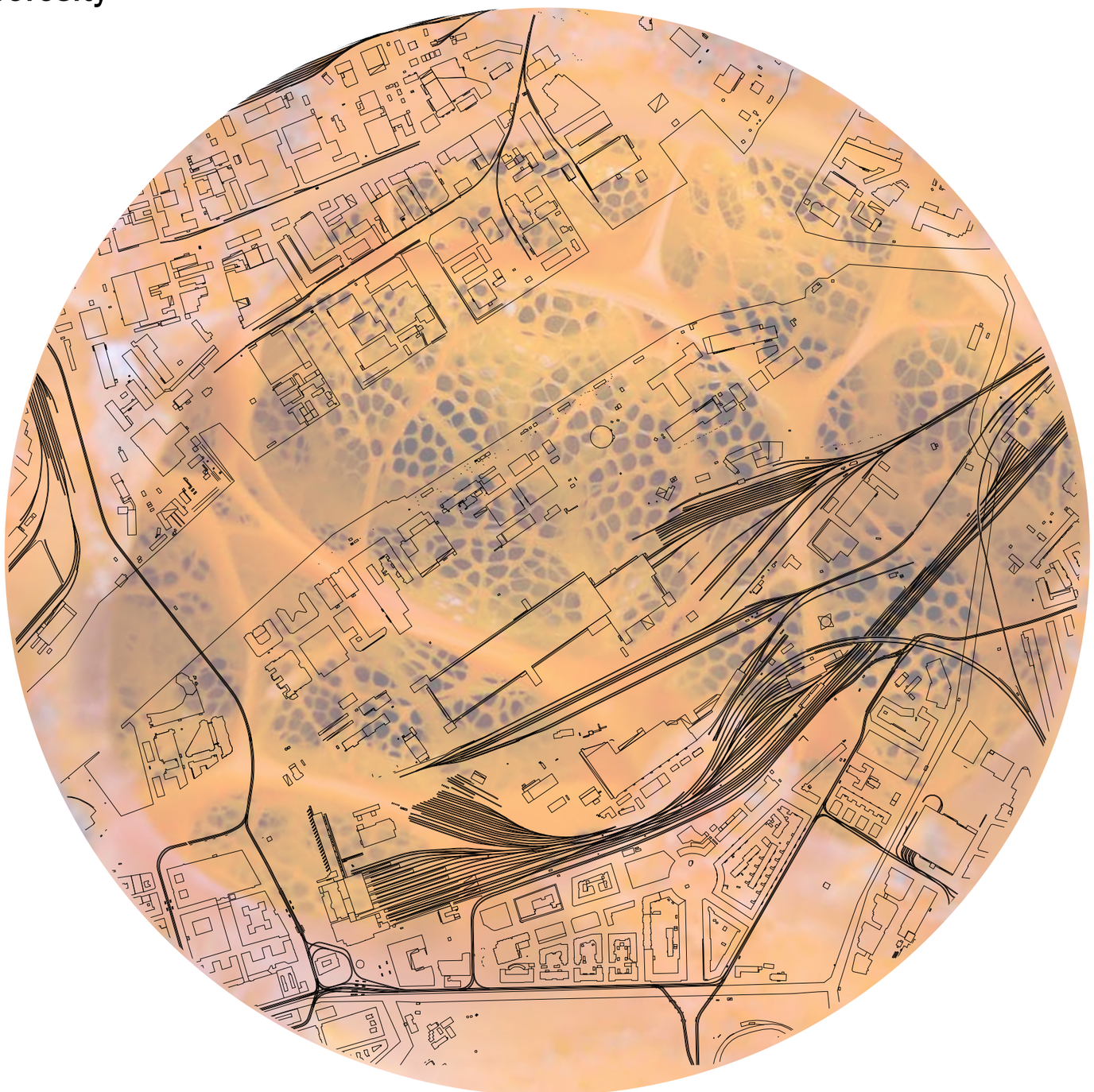
1 Länsstyrelsen i Västra Götalands län (2012)
2 European Environmental Agency (2012)

Gullbergsvass

current section

section A scale 1: 5000

urban porosity



An urban porosity for Gullbergsvass is proposed meaning to recreate the wetland that was there before.

The area was juxtaposed with a picture of a sponge to imitate the nature of this animal in the process of filtering and absorbing water.
The wetland is then conceived as a large scale park allowing people to learn with the process.
This park could provide with a place where people mix taking advantage of its democratic position within the city (being quickly accessible by public transportation from different neighbourhoods).

sponge def.

prorifera bearing pores

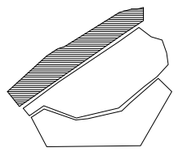
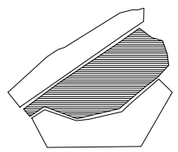
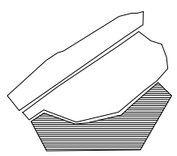
“simplest form of multicellular animal”

“filter feeders”[1]

1 Wikipedia (2013)

Background image Orange sponge by Kenneth Kopp©.

matrix

strip	problem definition	function	action	type
 1.5	sea level rise +++ extreme weather event +++ increased precipitation ++ heat island effect +	deposits	change land use	porosity park
		public realm	adapt	porous infrastructure (D)
		cultural heritage	adapt	facade tight/alt. entrance/porous infrastructure (G)
		offices	adapt	flood tolerant/alt. entrance/porous infrastructure(G)
		parking/streets	adapt	porous infrastructure (D)
 1.8-2.3	sea level rise ++ extreme weather event ++ increased precipitation +++ heat island effect +++	logistic	change land use	porosity park
		cultural heritage	adapt	porous infrastructure (G)
		parking/streets	adapt	porous infrastructure (D)
 2.8-3.2	sea level rise + extreme weather event + increased precipitation +++ heat island effect +++	train station	adapt	porous infrastructure (C)
		housing	adapt	porous infrastructure (G)
		offices	adapt	porous infrastructure(G)
		parking/streets	adapt	porous infrastructure (D)

Park boundaries

scale 1: 7500

To address the problem the thesis used as tool a matrix to manage the complexity of the site. The terrain was then divided in three parts answering to the site's topography in order to categorize the different problems.
The different solutions corresponds to the different typologies and can be summarised in Conduct, Gather and Delay and are represented schematically as rectangles (pores) in this image. The buildings to be conserved are adapted considering its function and the solutions are specified within the matrix.

The thesis focus then on the denominated porosity park where a change on the use of land of the site is proposed. The deposit areas and the logistic centres are suggested to become the park in itself.
These plots are own by the municipality and they are certainly not appropriate to be used to store and distribute goods as the area is highly vulnerable to floods, which may cause a stop in the supply of a whole region.

The boundaries of the park are then illustrated in the image with the dot-dash line.

The conception of the park departures from the strengths of Gothenburg housing different research institutes and universities giving the opportunity to use the site as a living laboratory developed together with its inhabitants.

The experience aims to give place to research on adaptation and bio-remediation mechanisms among other sustainable practices generating social interaction and community outreach. New enterprises and the self sustainability of the park is expected by the production of energy, cultivation and by expanding the social network of those who want to be involved.

phases

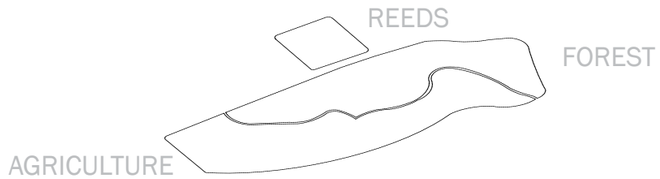
01. INCLUSION

02. EXPANSION

03. PRODUCTION

phases

The proposal conceived as an open-ended design is addressed in five project phases over a time frame of twenty five years in which the project will evolve.



The framework is based in three different landscapes: reeds, forest and agriculture responding to three different themes: biodiversity, energy production and people and their activities. These ones are disposed aiming to provide the park with identity and addressing the flood issue.

Different programs are to sustain the park as productive, envisaging different architectural elements that will be defined over time.
The thesis suggests for instance bio-energy facilities to use the resources of the park (reeds), aeolian forests providing energy for illumination and pumps, the refurbishment of the *gas klockan* into a green house transforming it into the park landmark showing the change of paradigm we are experiencing, scenes for cultural activities and market places to commercialize the vegetables and fruits produced within the park, as well as sports and recreation facilities.

04. ADAPTATION

05. RECONDUCTION

layers

These facilities are included as a way to increase the socially porosity but also to receive water when the situation requires it.

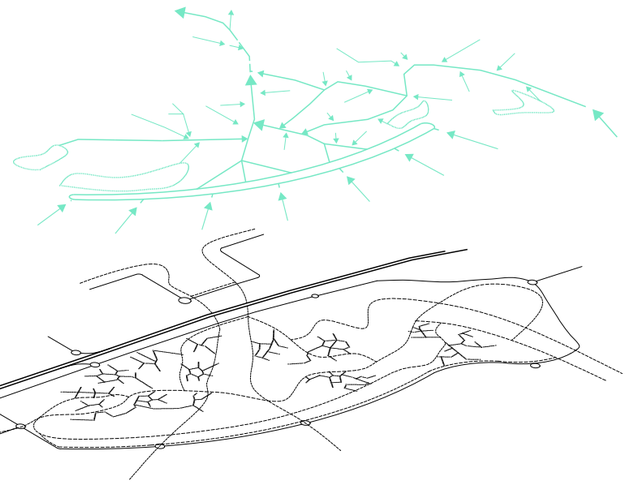
Molndalsån as mentioned before reaches Göta river by a culvert, the thesis proposes to reconnect it naturally giving the tributary room to grow when it is needed.
The image presents the different layers the framework of the park is composed of.
The sponge will be composed by urban agriculture, woodlands and flood-friend architectural types.
The wetlands pretends to filter and purify storm water and later on Molndalsån.
The layer of water recreates the shoreline that once was and leads the purified storm water to Göta river.
Regarding circulation the park emphasizes in pathways envisaging some of those elevated to be used when the park is flooded.

The park will provide the city with several services but its main goal is to operate as a sponge purifying and absorbing the water though it is expected to be flooded and allow its transformation over time.

sponge

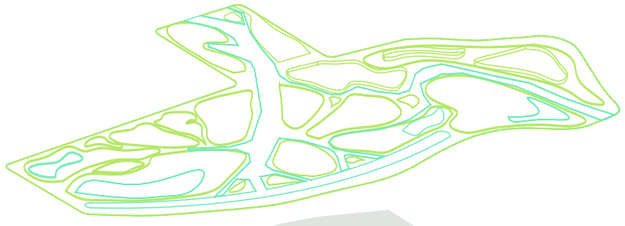
wetlands

water circulation



circulation

topography



context

phases

scale 1: 6500

phases

scale 1: 6500

phases

scale 1: 6500

phases

scale 1: 6500

phases

scale 1: 6500

porosity Park

layer_water

scale 1: 6500

layer_sponge

scale 1: 6500

layer_circulation

scale 1: 6500

layer_wetlands

scale 1: 6500

layer_activation

scale 1: 6500

layer_new developments

scale 1: 6500

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by Fabiana Tomé