

A grayscale illustration of a rainy urban scene. In the foreground, a person in a long coat and boots walks with a black umbrella. To the left, another person in a striped shirt and jacket walks with a checkered umbrella. In the middle ground, a person on a bicycle is also under an umbrella. The background shows a modern building with a curved facade and a sign that says 'SHOP'. The sky is overcast with rain falling. The overall mood is somber and practical.

# FLOOD RESILIENCE 2.0

Sustainable Urban Design  
Adaptation For Flood  
Resilience In Hamburg, Germany

Shenol Shahin Ahmed



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Adaptation For Flood  
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Master Thesis Booklet

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## PREFACE

Hamburg is one of the cities which is vulnerable against floods because of low lying lands, located on one of the major rivers in Europe, Elbe and short distance to the ocean, that means tides affect the city a lot. Even though there are some defenses as like dikes and walls has been built, climate change and its effects will make these less useful by time against the sea level rise and increasing amount of precipitation.

### GOAL

The goal of this thesis project, for a site in Hamburg, is: "To achieve a more flood resilient area while following sustainable development tools and finding out what the city needs, what potentials the site has and how the problems could be solved in a holistic approach"

### PRINCIPLE

To answer these questions:

What?

Why?

How?

## ABSTRACT

This thesis project is aimed to answer the questions; What could be done to design areas for making them flood resilient? How can sustainable urban design be adapted to provide flood resilience while transforming an area into a more livable space?

Starting with these questions, the past of Hamburg and existing situation have been analyzed, a research has been done about the floods, climate change and how other cities develop their strategies to minimize effects of these issues. With a holistic way, information about the site in Hamburg has been gathered to find out the current problems like connection issues, lack of public realm, non-attractive river front and outdated flood defenses.

As an input of all of this information, strategies have been made to give a better living space for residents of the site and the new comers from around the neighborhood, a more resilient area against the floods, better connections to the center, within the area and to the riverside. Activating the areas by adding mixed-use buildings and plazas surrounded, connecting by green corridors and bike lanes were the end results.

# INTRODUCTION

# ABOUT FLOODS

There are three common types of flooding which are Coastal (Surge Flood), Fluvial (River flood) and Fluvial (surface flood).

**Coastal (Surge Flood):** This type of flooding happens in areas that are on the coast of large body of open water, a sea and ocean. Severe weather causes excessive tidal conditions and as a result typically flooding occurs. This type of flooding by the storm surge leads water to overwhelm the low-lying land.

**Fluvial (River Flood):** When heavy rainfall occurs for longer period of times it causes a river to exceed its capacity. Heavy snow melt and ice jams might also cause this type of flooding.

**Pluvial (Surface Flood):** In this type of flood events, heavy rainfalls can cause excessive amount of water on surfaces which lack capability to redirect it to another place quick enough even though there is no water body is present nearby.



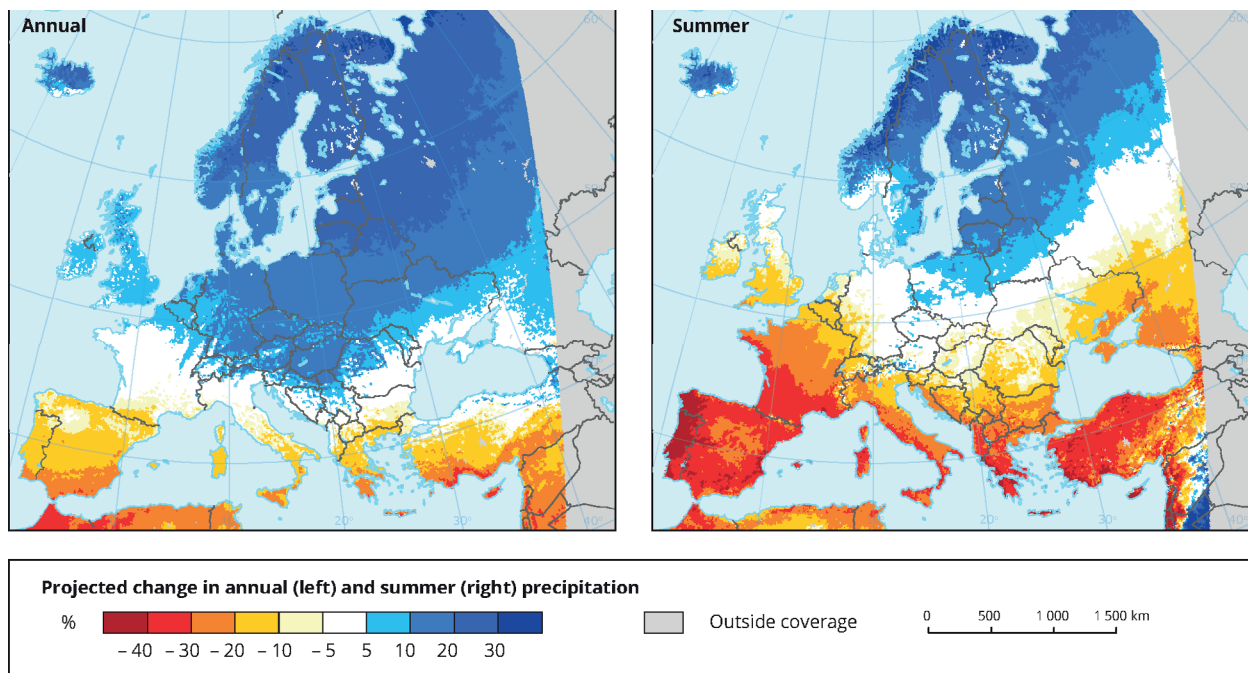


# CLIMATE CHANGE AND SEA LEVEL RISE

The major cause of sea level rise is climate change which became the forefront for global warming which cause the heat evolved from human activities, since the pre-industrial period, primarily burning of the fossil fuel, which increase the greenhouse effect in Earth's atmosphere. Global warming causing mean sea level to rise by melting glaciers and ice sheets and adding water to the ocean. Due to the increased in Earth's temperature the volume of the ocean is expanding as the water warms. The other contributors to the sea level rise are the decline of water from land to ocean due to ground water pumping, terrestrial water

storage and sediment inflow from land, change in ocean currents and change in atmospheric pressure. These factors are the major cause directly connected with sea level rise as geophysical phenomena and climate change.

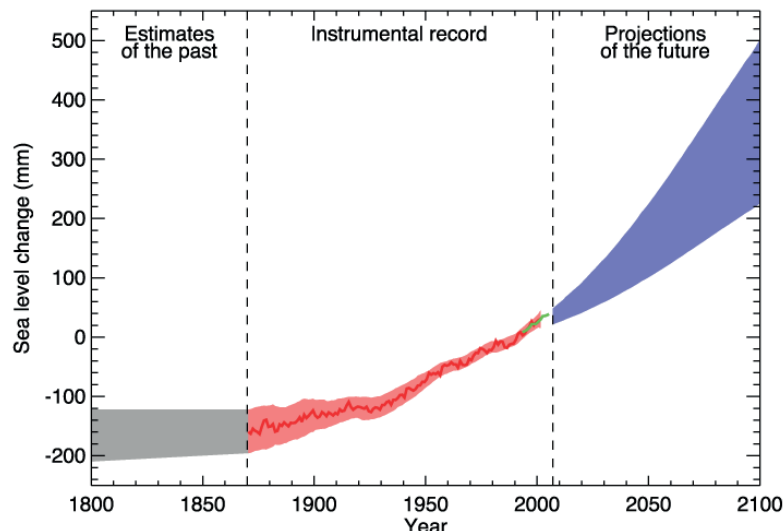
Below maps (Source: European Environment Agency) show the projections for the annual and summer precipitation change and that will increase mainly in central-northern parts of Europe which includes Hamburg, Germany.



Scientists forecast more rainfall overall, but say the risk of drought in inland areas during hot summers will increase. More flooding is expected from storms and rising sea levels. There are, however, likely to be very strong regional variations in these patterns.

It is crucial to analyze and investigate the contribution of these climate factors in order to forecast future changes in sea level rise. Much studies have been taken in this regard for such future predictions and expectations, this observation and estimation is normally termed as sea level budget. Climate science is working on how to decrease the gap between these values. Furthermore,

the rise in sea level is combination of the ocean volume changes and local crustal and land movement. The rise in sea level relative to land is the external force affecting coastal zones, it is crucial to forecast the relative sea level rise in order to estimate the impacts of this rise. The factors such earthquakes also play a role in the climate change. Regardless Hamburg is being far from the ocean but it is crisscrossed by the canals and is still persuadable to sea level rise. The rate of sea level rising is a real challenge, we can slow it down by cutting emissions and if we limit or control the global warming.

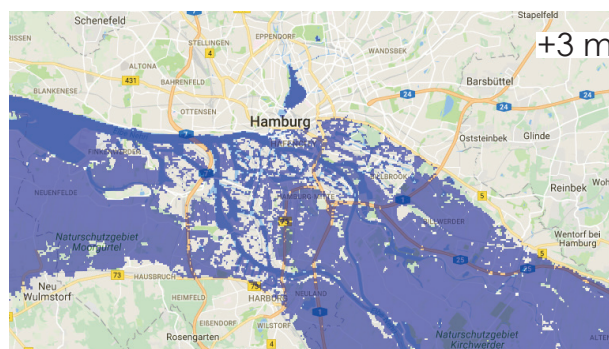
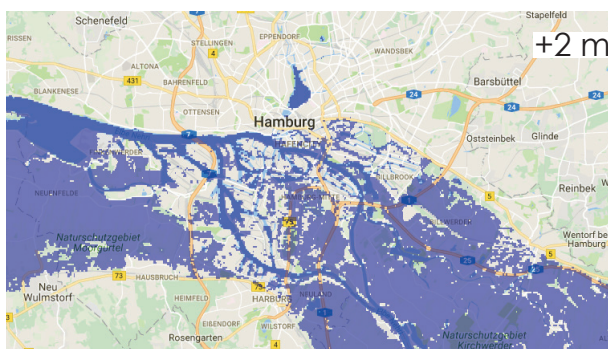
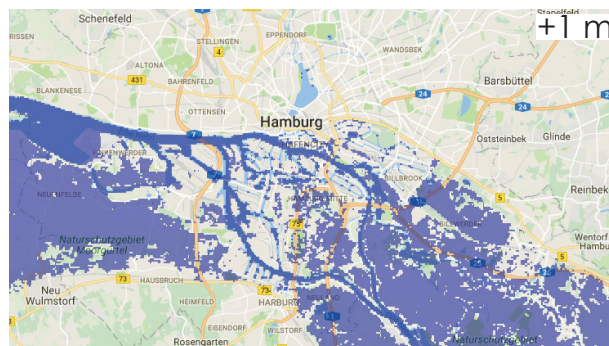
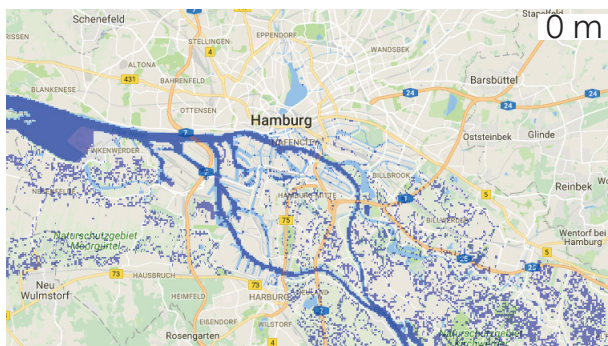


Past and projected global average sea level, Source. IPCC (2007)

# PROJECTED SEA LEVEL RISE AND ITS EFFECTS

The projected sea level rise for mid-range scenario for Hamburg is considered between 0.5m-1.0m based on different representative concentration pathways (RCP) defined by the Intergovernmental Panel on Climate Change (IPCC). On the other hand if we consider the pessimistic scenario they have predicted more mechanisms of ice melting and have estimated the projected sea level rise up to 1m-2.5m by the year 2100 and a projection of 10m by the year 2300. The range between these values also

represents the increasing uncertainty in the sea level rise after year 2050 this spatial variability includes the whole Europe and also the individual countries like Hamburg and other low elevation coastal zone cities of Europe. Coastal flooding in all the areas of Hamburg will be the direct impact of projected sea level rise in coming years. This is estimated for coastal areas, while the extreme cases will be if the projected sea level uncertainty increases with time.



Projected sea level rise for every 1 meter and areas in Hamburg which will be affected, Source: GeoBasis-DE / BKG

# CITIES UNDER THE RISK OF FLOODING

The sea level is rising day by day globally up to one meter by the end of every century, setting many towns vulnerable to flooding.

## **Venice**

In every winter season Venice and its population ought to compete with the acqua alta, this name is given to the abnormally excessive tide that sees floodwaters flow through the streets, harming the properties and interrupting the daily activities of Venetians and visitors alike. The havoc and damages that has been as a result of the yearly floods, now a part of the daily routine life for the city's all inhabitants and it is very hard to quantify.

## **Amsterdam**

The Dutch have constructed a complicated system of dikes, levees, dams, and floodgates over the past few years that together prevent floods and rising sea level and prevent the risks. Netherlands' defenses are much stronger than ever, specialists are hesitating to relaxation on their acclamation and continuously comparing the flood safety systems for any loose ends.

## **Hamburg**

Venice and Amsterdam are apparently sure candidates for floods, however the 2nd biggest metropolis in Germany

likewise at extreme danger from flooding is Hamburg City. Hamburg is at the same row to be hit by flood after the above mentioned cities due to global warming.

## **Saint Petersburg**

Saint Petersburg is also a coastline city of the Southern Baltic Sea and is at most risk of being flooded by the rising tides. The city has seen the rise in the temperature levels and climate changes which will be a reason for episodes of flood and an anticipator for the rise in the sea level. These all the changes in the sea level are due to climate change and rise in temperature that the city has noticed over the past few years.

## **Los Angeles**

Los Angeles sits 3 meters higher than its sea level this may also increase the trouble posed due to global warming and climate change. According to the specialists, by the year 2050 sea level may rise so drastically that they start to threaten public spaces, infrastructure, business, daily routine life and tourism.

## **New Orleans**

New Orleans is facing acute danger of flooding due to its geographical position, most of the city sits in a bowl formed dip and its lowest point is located more than 10 feet below the sea level.

# MULTIFUNCTIONAL FLOOD DEFENSES

Multi-functional flood defences are structures planned to safeguard land against the floods, these defences are also being utilized for different purposes, like transport, lodging, shipping, nature, and agriculture. Different examples of multi-functional flood defences includes a dike with a road on top, house with retaining walls against water and parking garages in ridges. In order to have an option to work as a flood defence these structures must be important for a whole flood protection framework, like dike rings in the Netherlands. This implies that the maintenance, review, control, inception and the formalisation of satisfactory safety levels must be organised.

In the case of Arnhem, Netherlands is a city merely 13 meters above sea level,

has experienced extreme weather over the last few years. The city is recognising the new threats posed by flooding and planners have been taking action to adapt the urban environment areas and 'live with floods'. The coastlines areas are designed as the flood defence structures. Water authorities are playing a significant part for flood defences. The Dutch Ministry of Infrastructure and Environment plays a leading role in this regard. Land use planning authorities and non-governmental stakeholders, for example, inhabitants are now associated with the execution of room for the river measures.

Arnhem, The Netherlands



The city of Doesburg was founded at the crossing of the IJssel and the Old IJssel. To improve the safety against floods, the water board had dikes constructed across the town. Part of those dikes were transformed right into a two level quay wall in the beginning of the 21st century. These protections are playing a significant part for flood defences. The Dutch Ministry of Infrastructure and

Environment plays a leading role in this regard. Land use planning authorities and non-governmental stakeholders, for example, inhabitants are now associated with the execution of room for the river measures.

#### Deventer, The Netherlands

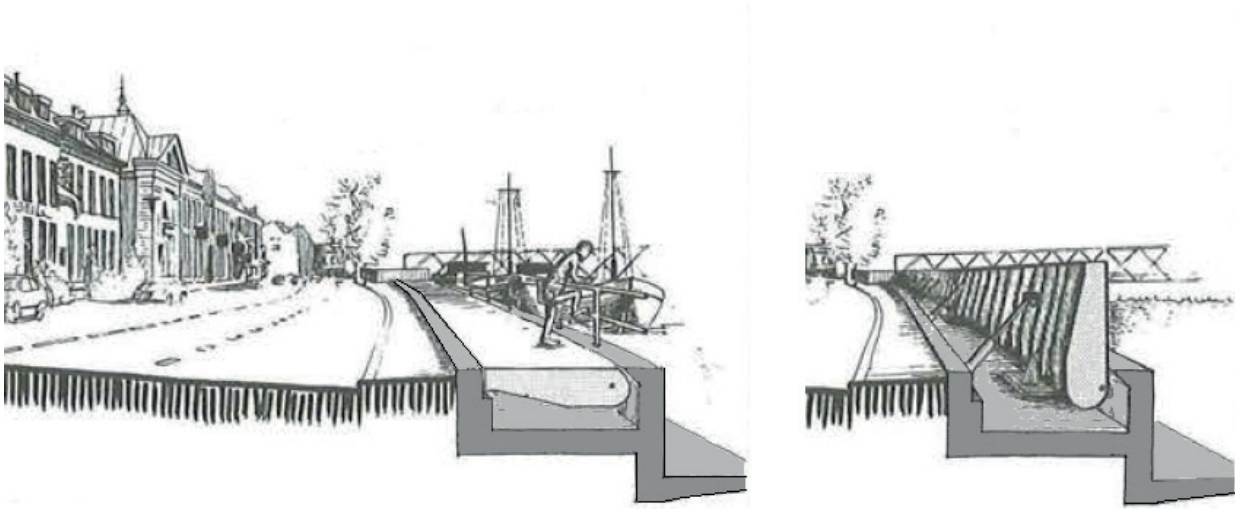


Doesburg, The Netherlands

The flood wall can be elevated



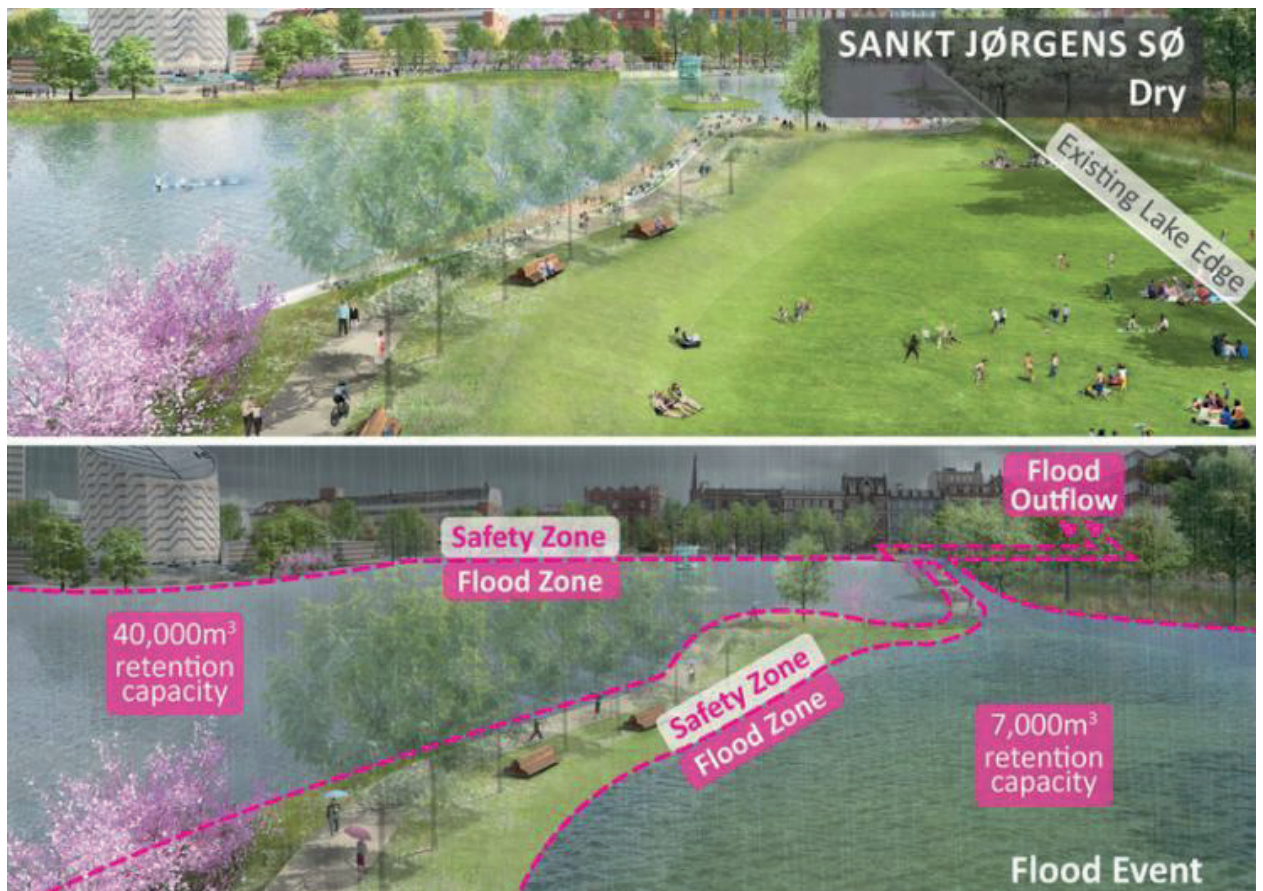
Design sketch of a flap gate in Kampen. Left: normal conditions, right: during high river discharge (TAW, druk op de dijken 1995)



Katwijk: sketch of the 'wall-in-dunes' alternative, with a parking garage combined in the flood defence



Copenhagen







# HAMBURG AND FLOODS

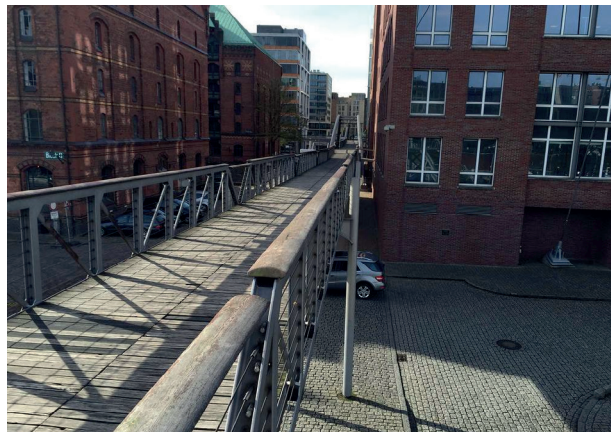
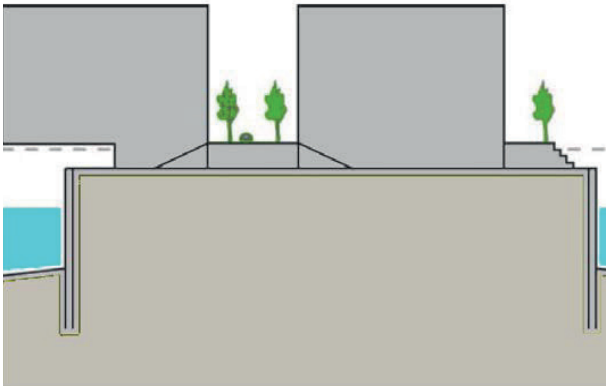
The Hamburg city was flooded in 1962, after that significant flood protection measures have been used to save the city from floods. After the natural disaster and floods affecting the Hamburg's major coastline region the city has developed dikes, horizontal slopes, erections and reinforcing them to make them stand against the floods. In the mid-90s, Hamburg's flood protection program was started to raise the height of retaining up to one meter around the coastline regions. Much of the Hamburg's area is redeveloped and the buildings near coastline are

surrounded by dikes to protect them against the flood.

It has become quite common for the city to suffer flooding as a consequence of severe rainfall. Back in the summer of 2002, more than 20 trillion litres of rain fell over Germany, leading to what is known in the German media as the 'flood of the century'.

Dikes and seawalls encompassing Hamburg are being elevated against floods. If we consider Hamburg history, it has faced flooding like the North Sea





flood and the Hamburg's well known fish market flooded by storm Sabine. In response, the dikes have been raised from 5m to a height of up to 9.25m since they were first built. Aside from developing shields, architects from Hamburg focusing on the planning of new constructions to be built on the concept of flood defenses. The buildings neighboring to the shores must be waterproof and give access to the

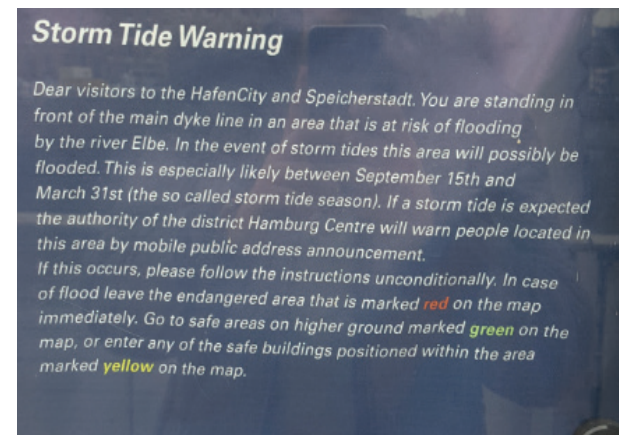
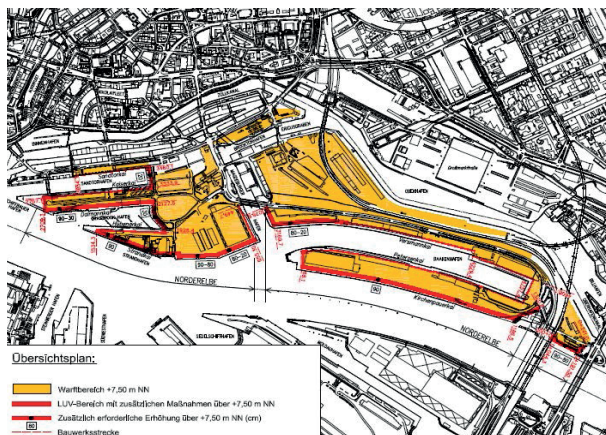
raised regions in the event of flooding. Meanwhile Hamburg is also counting on the renovation of the old dikes over coming years to hold back the sea level rise. Hamburg has the possible consequences of high tides and flood predictions before the century ends. It acknowledges that building resilience against the flooding is a long-term process depending on different factors.

# HAFENCITY

In the beginning of the 21st century a redevelopment project of an old harbor area, named as HafenCity, was started. This newly developed HafenCity in Hamburg is one of the major projects of urban development where the “Grosser Grasbrook” region of the previous Hamburg vacant port is being reinvigorated with new living, shops, workplace buildings, recreation, and culture and housing areas. In this newly developed city dikes have been taken into consideration to defend the lands from flood surges, it might had been impossibly expensive and moved away from the approach. Instead, there are strict flood-safety guidelines in the places with in the special improvement zone, which includes requiring new roads and public areas to be constructed on sand terraces over 25 feet above the normal high-tide line. Buildings alongside the shore continue

to be at their actual degree however ought to be waterproofed as much as the elevated-road degree.

Below some photos of the informational signs from the area are shown in addition to a map of Hafencity and the dikes.



# **ANALYSIS**

# GERMANY

## Location

Germany as the most populated country in European Union, is located in central-western Europe. It covers an area of 357,021 square kilometers with over 82 million inhabitants (Destatis.de, 2017). Germany is the second most popular immigration destination in the world after the United States (Population Division, 2015).

## Governments and Boundaries

Germany consists of 16 constituent states. Germany's capital and largest city is Berlin with population of 3,7 million (Amt für Statistik Berlin-Brandenburg, 2016). The other major cities are Hamburg, Munich, Cologne and Frankfurt.

## Biodiversity

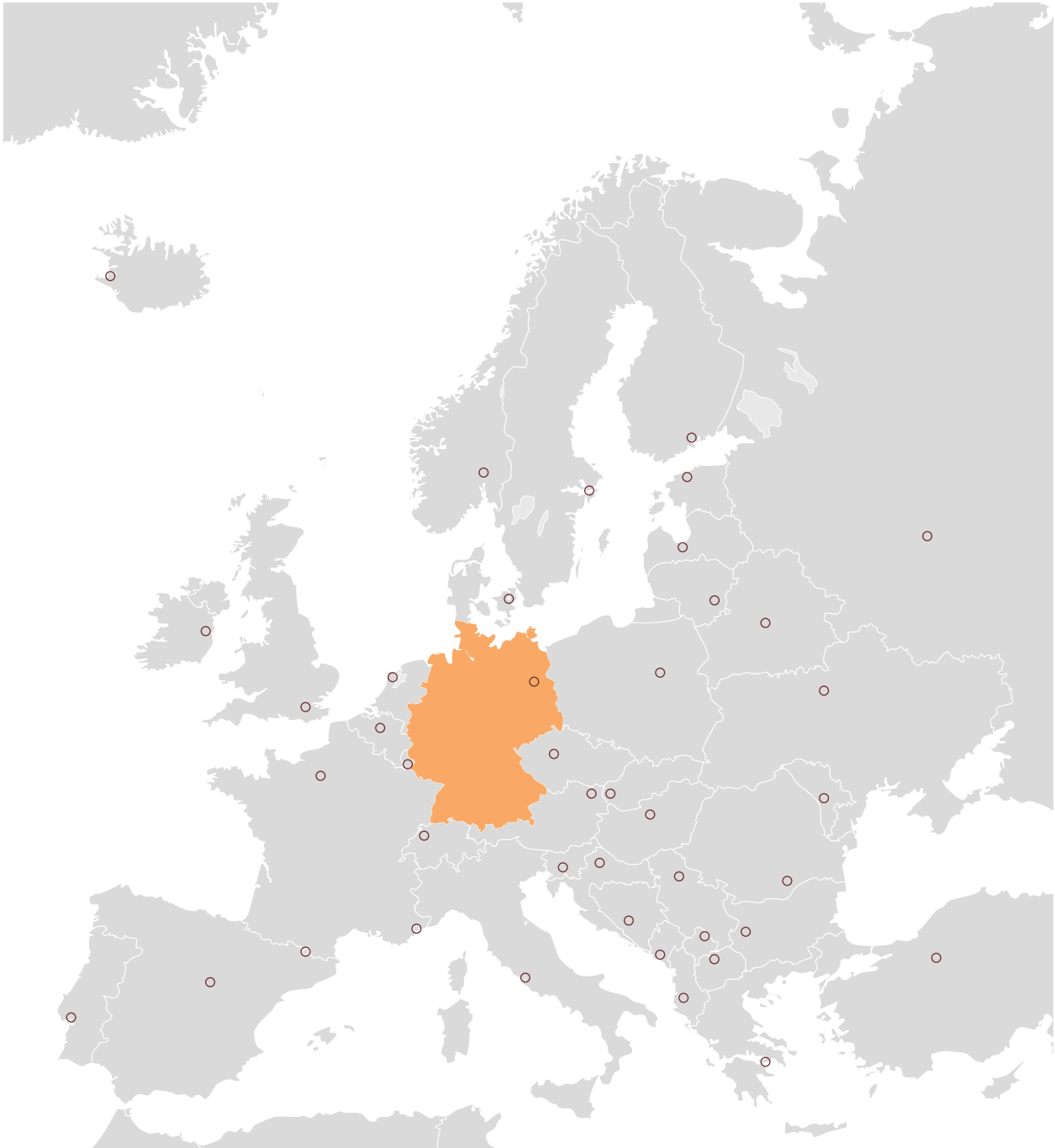
Germany could be subdivided into two ecoregions as European-Mediterranean montane mixed forests and Northeast Atlantic shelf marine (WWF). Majority of Germany is covered by either arable land (%34) or forest and woodland (%31.1); permanent pastures covers an area of %13.4 and only %11.8 is covered by settlements and streets (Strohm, 2010).

## Climate & Natural Disasters

Germany has a largely temperate seasonal climate dominated by the westerly winds. The country is located in between the continental Eastern European and the oceanic Western European Climate. North Atlantic Drift moderates the climate, the Northern extension of Gulf Stream. Because of the warmer water in the areas of the borders of North Sea, in the northwest and north climate is oceanic. Precipitation is calculated as an average of 789 mm (31 in) per year and no consistent dry season exists. Temperatures might exceed 30 °C (86 °F); winters are generally cool and summers be subject to warm (GermanCulture).

## Underground Sources

Germany has different kinds of underground sources and the majority is on; coal, lignite, natural gas, iron ore, copper, nickel, uranium, potash, salt, construction materials, timber, arable land (CIA).



# NATURAL AND SOCIAL ENVIRONMENT

## Environment + Resource Use

Air pollution is a current issue caused by the emissions from coal-burning utilities; forest damaged by the acid rain because of sulphur dioxide emissions; raw sewage and industrial effluents from rivers pollute the Baltic sea.

## Natural Hazards

Heavy rainfalls cause rivers to flood such as during the 2002 European floods and the storm surge effects the neighboring cities to the North Sea such as the flood in 1962.

## Energy

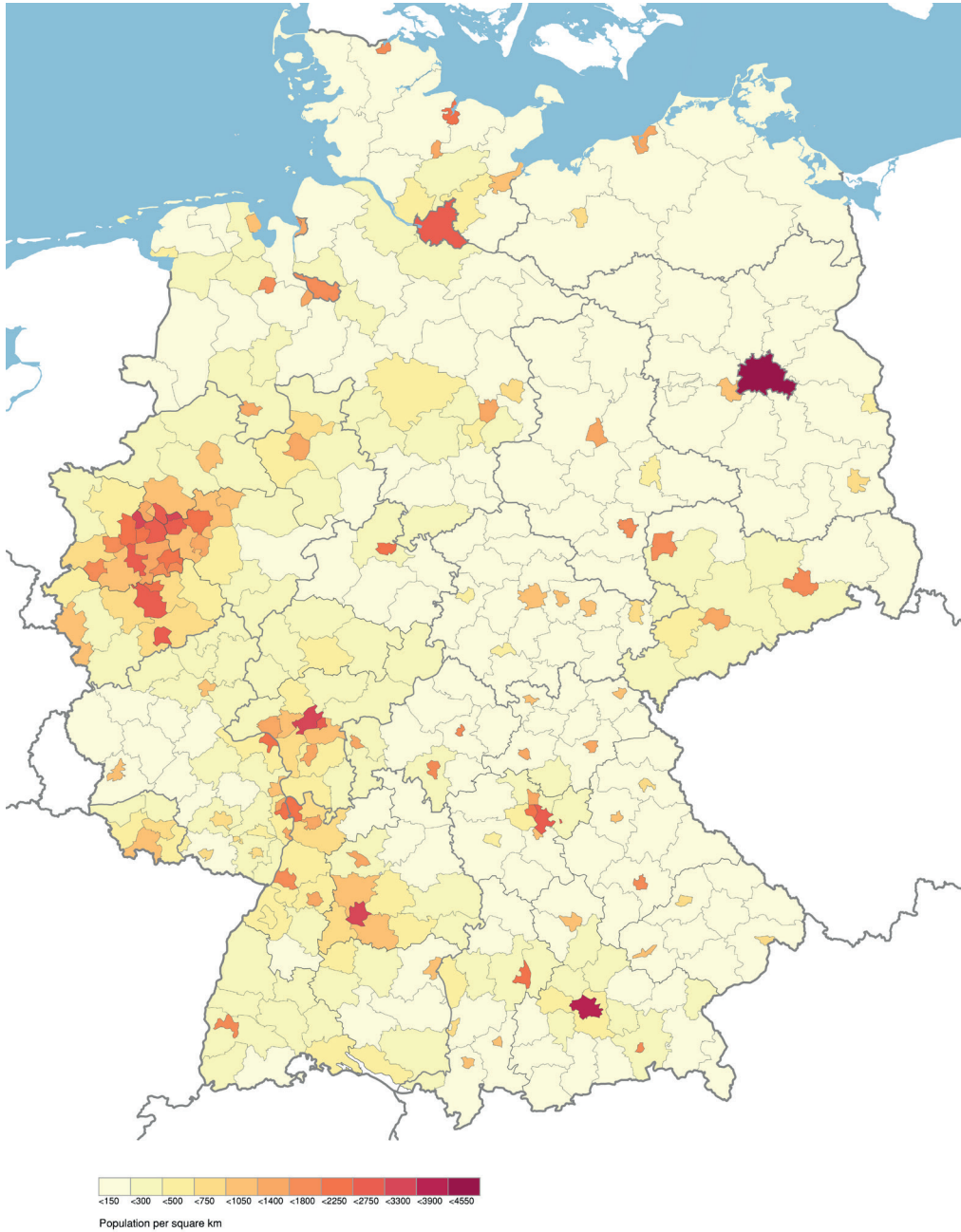
Germany is sourced mainly by fossil fuels, followed by nuclear power, biomass, wind, hydro and solar. Since the German economy is large, ranking fourth in the world by GDP (IMF), in global energy consumption ranking Germany ranked sixth between 2004 and 2007 (EIA). Germany was Europe's largest consumer of electricity. In 2013 Germany's electricity production reached 631.4 TWh.

## Social Aspects

Germany has reached population of 82,8 Million in December 2016 (destatis). The country ranked as 16th of most populous countries. According to the United Nations Population Fund Germany is the second-highest number of international migrants worldwide, behind the US at number one. The population of foreign/immigrant descent reaches over 16 million, a large portion of them, %96.1 lives in western part of Germany and Berlin. The majority of foreigners are Turkish, followed by Polish, Syrian, Italian and the other nationals.

Population projections based on 2015 numbers, estimated as number of inhabitants will increase in the next five years, before decreasing to the current level of 82.2 million in 2035. Afterwards it will continuously fall to 76.5 million in 2060 (destatis).

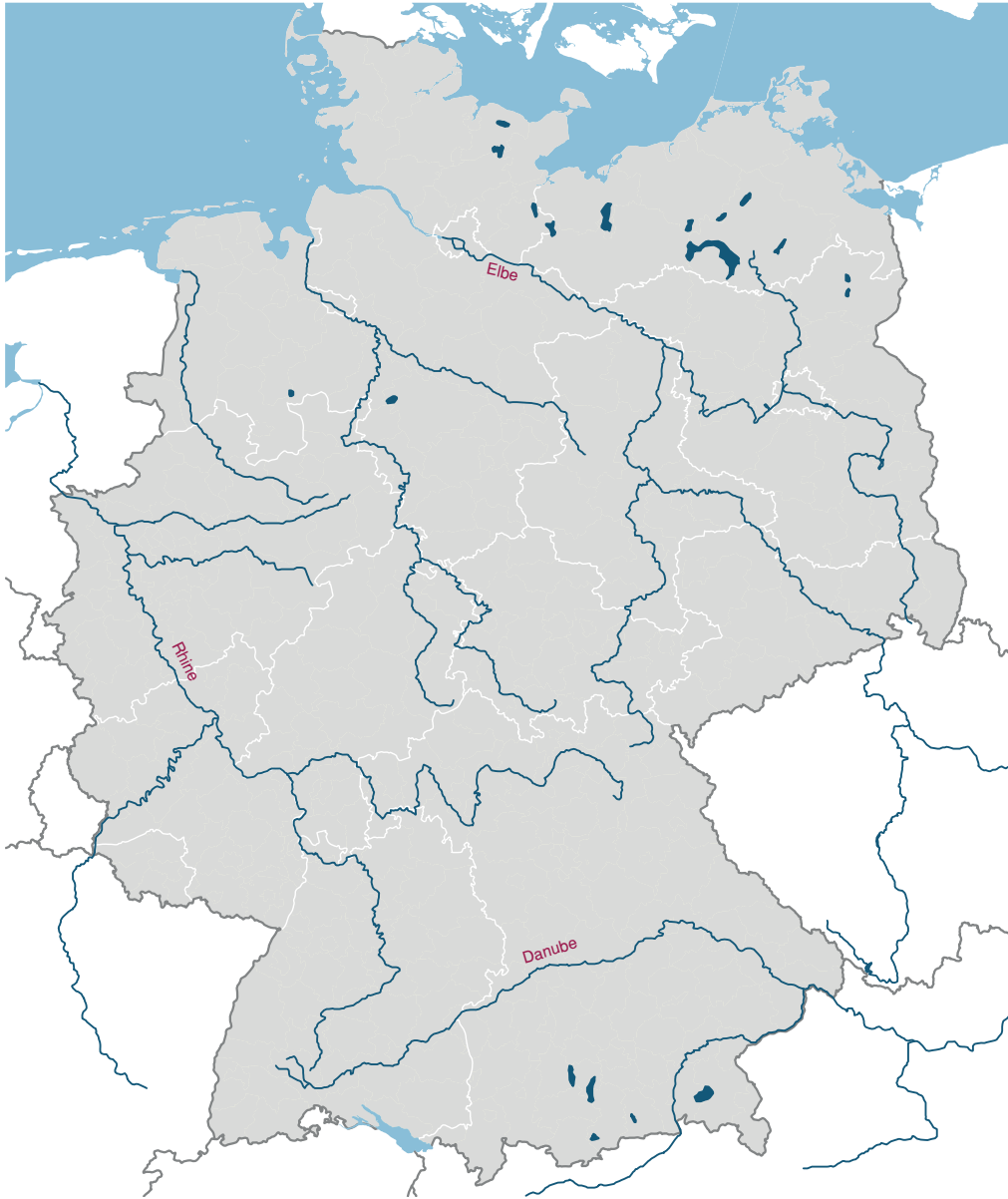




Population Density in Germany

## **WATER BODIES**

Germany is connected to the Baltic and North Sea and accommodating several lakes, specifically in north-eastern side. The country drains North Sea through the Rhine, the Ems, the Weser, the Saale and Elbe Rivers. A small region from north and northeast of Hamburg drains into the Baltic Sea through the Oder River. Germany's longest rivers are the Rhine and the Danube. The Rhine is one of the important rivers in Western Europe. The Rhine rises in Switzerland, then flows into Lake Constance and to the west. The Rhine gets a consistent flow from the melting snow in winter, in summer Neckar, the Main and the Moselle fed the Rhine. The Alpine Foothills are flecked with different lakes water. At better rises, icy lakes transfer to the shiny charm of the Alpine meadows.



Water Network in Germany

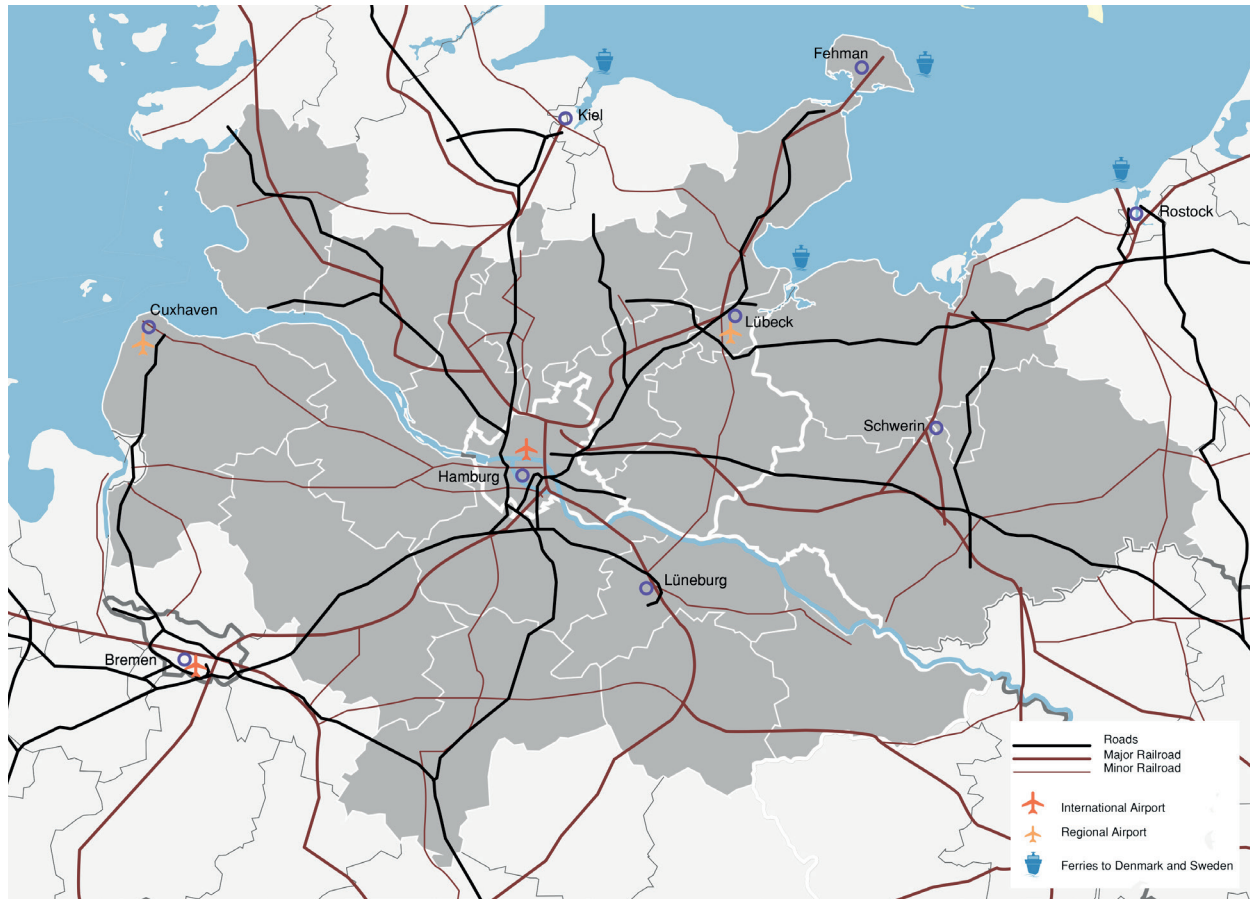
# HAMBURG METROPOLITAN REGION



Hamburg Metropolitan Region (HMR) covers a heterogeneous area of urban and rural, collapse across 8 districts in the federal state of Lower Saxony, six districts in the country of Schleswig-Holstein and two districts in the state of Mecklenburg-Vorpommern related to the city-state of Hamburg itself with almost 5.4 million inhabitants. The region is the largest port of Germany and has developed strong clusters, ranging

from its traditionally leading maritime, logistics, and port-related industries to aviation, renewable energy, and life sciences. HMR partake a strong economy and it fell behind all other regions in the Germany in terms of gross domestic product per capita growth between 2005 and 2015.

# TRANSPORTATION



The collaboration of the transport remarkably through the Hamburg city by the Hamburg Traffic Association is very successful but enormous contrast remain as for as public transport accessibility is concerned within the region, especially among metropolitan and rural areas, which is raising difficulties for additional economic integration and regional cohesion. The region offers a diverse range of cultural,

natural and recreational assets, but these remain underexploited due to separate branding approaches and there is no coordinated tourism offer for the region.

# HAMBURG

Hamburg is a significant port city of the northern Germany. It is associated with the North Sea by the Elbe River. It is interweaved by many canals. Furthermore, it includes huge parkland areas and Inner Alster Lake which is dapped with boats and surrounded by cafes. Hamburg is Europe's third biggest port. Hamburg is a significant international and domestic tourist attraction point. Hamburg has rivers, waterways, canals and these water channels are crossed by around 2500 bridges, making it the city with the biggest number of extensions in Europe. Beside its rich architectural heritage the city also has valuable cultural settings, for example Elbphilharmonie and Laeiszhalle concert halls. It gave birth to the movements like Hamburg Schule

and paved the ways for musical groups including Beatles. Hamburg is well known for a very long time for several theatres and a variety of musical shows. Hamburg has significant architectural buildings in a wide range of style with no skyscrapers.

Furthermore the city is growing and expected to grow. Population growth in Hamburg from 2011 with forecast up to 2030,

Scenario 1: +50000 inhabitants

Scenario 2: +100000 inhabitants

In ongoing collaboration with the housing industry the city aims to ensure that at least 6,000 new apartments are built in each of the coming years.

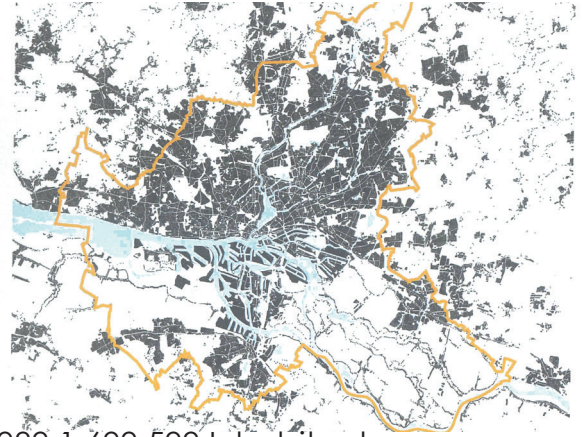




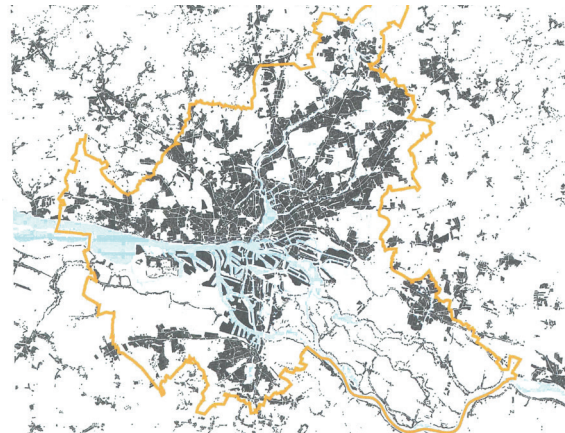
# HISTORICAL DEVELOPMENT



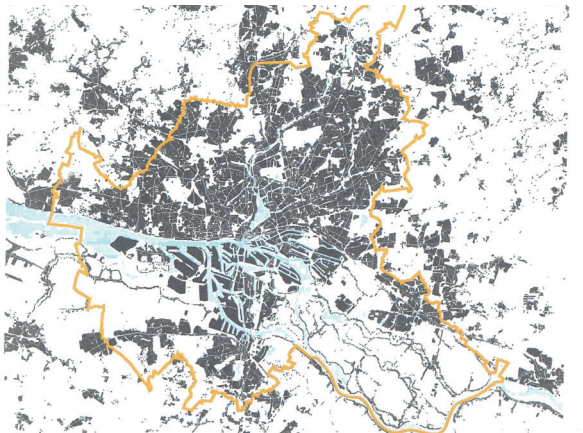
1920 1,010,790 Inhabitants



1989 1,699,599 Inhabitants



1960 1,823,574 Inhabitants



2007 1,741,182 Inhabitants

The development of Hamburg starts in the 9th century as a mission settlement to change over the Saxons. From the middle ages time, Hamburg was a significant trade center for Europe. The location of its ports, freedom of the city and as a state for centuries reinforced Hamburg's position. World War I in 1914 carried progress to a stop. After the war, for a long time, Hamburg couldn't

make any further development. The immediate possibility of extension, with the improvement of these regions on a premise of large-scale planning was broken by the outbreak in 1939 of World War II. After the war in 1945 Hamburg started to progress quickly, business blossoming was the tremendous new business district City-Nord built in 1960.



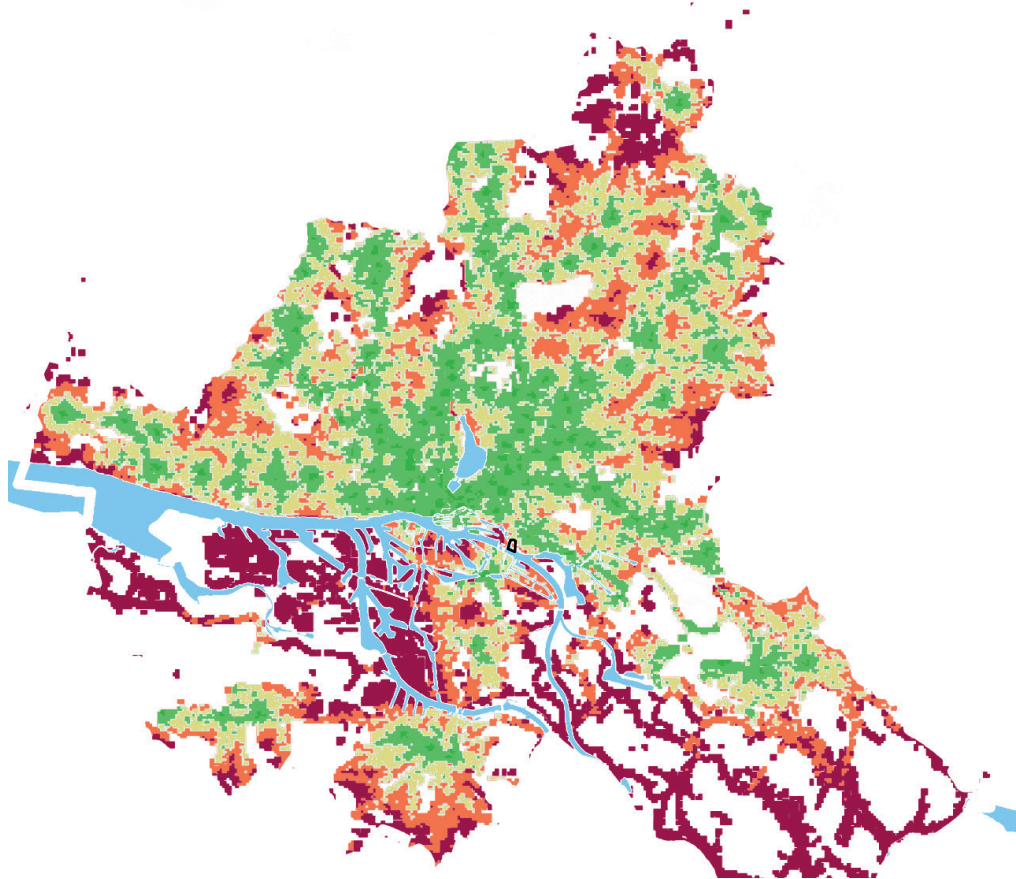
## DISTRICTS AND MAJOR ROADS



Various motorways and federal highways connect Hamburg with different urban areas and cities. A7-crossing the Elbe waterways, is a significant motorway for the north-south association in Europe, from urban communities of Kiel and Flensburg in the north to Hanover in the south. The Bundesautobahn 1-crossing connect Lübeck to Bremen, Münster, and

Dortmund. The federal highway 5 runs from the Danish line in the north to Frankfurt in the east of Germany. Hamburg with 103 districts is a vibrant and modern metropolitan region, going from enthusiastic and lively urban settings to pure rural neighborhoods. The districts in Hamburg include, Altona, Eimsbüttel, Mitte, North, Wandsbek, Bergedorf, Harburg.

# ACCESSIBILITY



Accessibility and high quality transport infrastructure with adequate limit and well managed urban spaces are the priorities of Hamburg City's urban development action plan. The government has been contributing to ensure this goal through the transport network.

According to an analysis (Data Source: Hamburg Municipality) made on the

accessibility features of Hamburg city, although areas close to the city center are easily reachable, there are connection issues to most of southern half of city and northern ends. Even though Hamburg has good railway connections and road network, these areas suffer from the lack of connection. The site is one of the darker spots of North of Elbe although city center is nearby.

# PUBLIC TRANSPORTATION

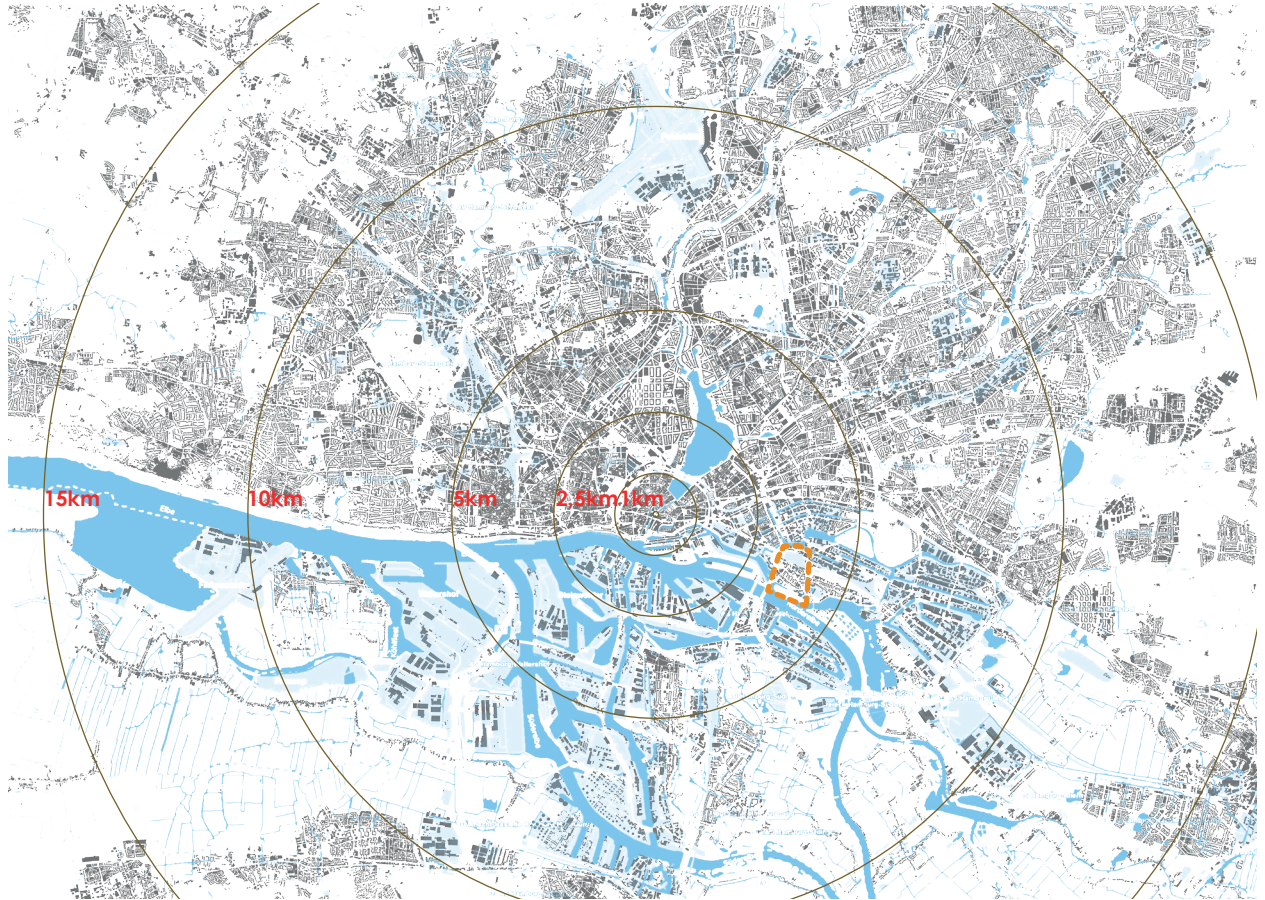
Hamburg's public transport framework is consisted of rapid transit and regional rail services that associate the cities to all the surrounding regions. There are underground lines, suburban lines and regional rail services that connects Hamburg to different urban areas in the region. These rail services are supported by a broad scope of transport services with metro buses, express buses, sprinter buses and regional buses which associate stations and encompassing towns. Hamburg city manages and coordinates with the public mass transport with busses, ferries and trains. These transports connects Hamburg to the Lower Saxony and Schleswig-Holstein and multiple districts. These operating public transport companies provide the collaboration services and customer services. The public network is

organized into five rings based on Alster Lakes which covers the city and will also take you away sixty kilometers from the city.

Hamburg has managed to alleviate traffic congestion and connect commercial and residential areas with the city center by extending public transport. All the rapid transit services and underground trains in Hamburg as well as most metro transports run each 5-10 minutes until around 11 pm on non-weekend days. The normal service is terminated at around 0.30 am. Then, at that point, night transport run in the city. During the end of the week evening from Friday to Sunday as well as before open occasions, the rapid transit services, underground trains and city buses run all the time



# WATER NETWORK AND DISTANCES



Hamburg is a rich city with its green spaces and water surfaces when estimated against the number of its inhabitants. Surprisingly, Hamburg is ranked in the greenest cities in the world. 19% of Hamburg's region is comprised of these green areas and 10% consist of water surfaces. The 164-hectare Alster Lake is in the heart of the city, as well as countless canals, waterways and rivers are the part of the city.

Providing abundant opportunities for sports and recreation and surrounded by the Alsterpark, the outer Alster Lake is the well-known metropolitan destination for the inhabitants.

Above is an analysis of the distances from the city center, Site is also shown and it is located within 40-50 minutes of walking distance.

## PUBLIC TRANSPORTATION

The climate of Hamburg has mild winters, a late spring, relatively cold summers, high humidity and frequent fog. The average temperature in winters is around 34 °F, while the average temperature in summers is 62 °F. Hamburg's climate is oceanic and fairly wet and windy city with prevailing westerly winds blowing in moist air from the North Sea. Summers are warm with rainy days, occasionally dry, sunny spells. Winters are cold, sometimes freezing to 2°C (28°F) in January, the coldest month, when the Elbe and inner-city lakes are known to freeze enough for ice skating. Snowfall is generally light, and Hamburg typically encounters just

a couple of heavy snowfalls each year, starting in early days of December, with sleet being the most common form of winter precipitation. Spring is very pleasant in Hamburg, when the city's thousands of trees bloom with a new coat of green and the days begin to warm up. Although summer is the most popular time for tourism, spring is the best time to visit Hamburg, not least because it is the season that best showcases the city's many parks and landscape.

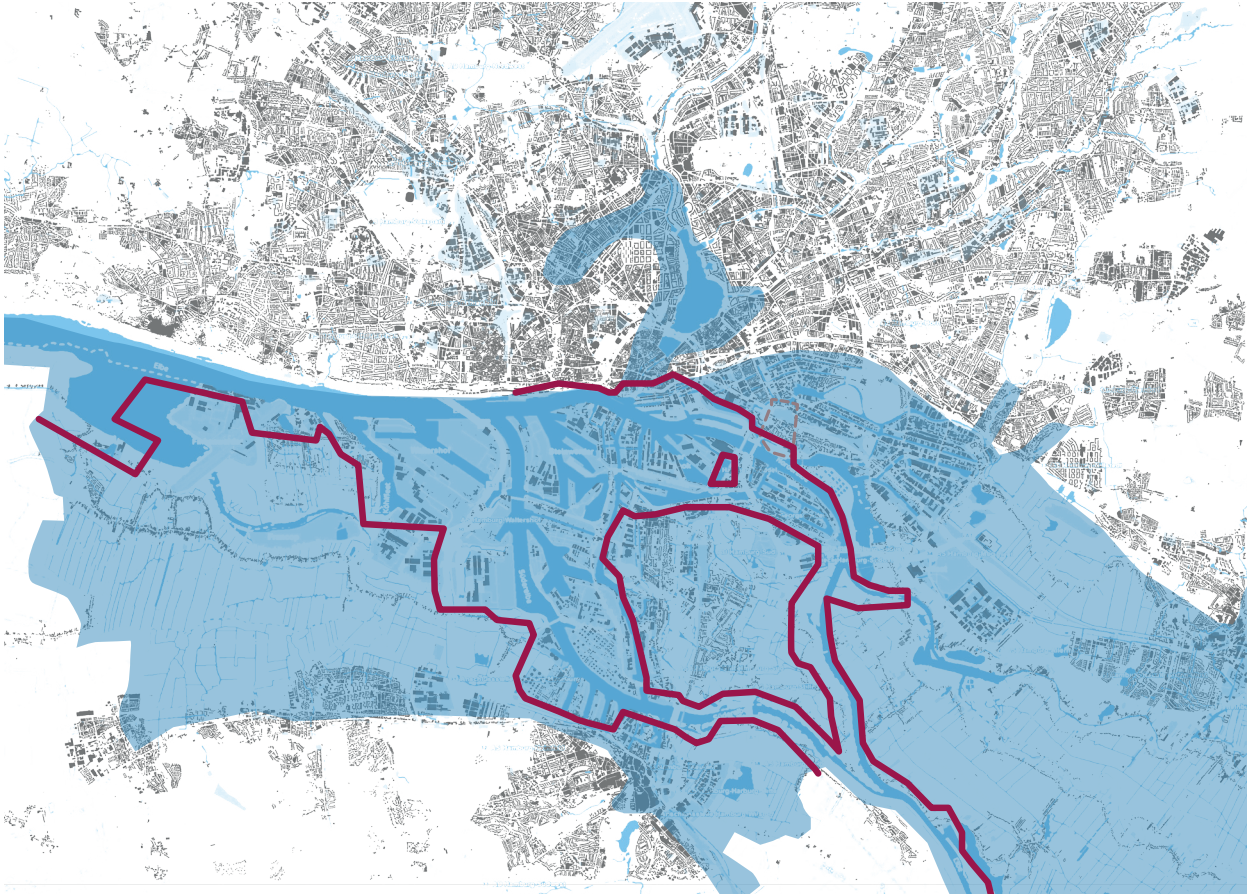
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average high in °C											
3	4	7	12	17	20	21	22	18	13	8	4
Average low in °C											
-2	-2	0	3	7	10	12	12	9	6	3	-1
Average precipitation - mm											
61	41	56	51	57	74	82	70	70	63	71	72
Days with precipitation											
12	9	11	10	10	11	12	11	11	10	12	12

## TIDES AND FLOODS

Hamburg's coastlines are connected to the tidal waters of North Sea and the Elbe River. The water level of these two varies between low and high tide. The water level of both water bodies rises with the flood tide for six hours from low to high water. The rise and fall of the water make a current that runs in the Hamburg. In the 1962, North Sea flood was a complete disaster affecting the coastal regions and surrounding areas of Germany and particularly the city of Hamburg. The flood destroyed the houses of inhabitants and loss of many worthy lives in the Hamburg. The extratropical cyclone was responsible for the flooding in the Hamburg and in the Germany. The sever flood and the disaster it caused severally affected the dykes more than the expected and lead to multiple breaches before officials raised the alarm during the flood in 1962. The flood hit Hamburg City very unexpectedly. Hamburg City collapsed almost completely as the flood destroyed the city scape and houses of the inhabitants.

According to the recent tide measure perceptions along the North Sea coast, outrageous water levels have arrived at greater height during the last forty years than before the supposed "flood of the century" that happened in 1962. The storm flood levels for both 1976

and 1981 were up to 50 cm higher than those in the 1962 occasion. Six storm surges higher than the 1962 level have also been recorded at the tide check station in Hamburg beginning around 1990. In the Ems estuary close to the line to The Netherlands, the storm surge of January 1994 was the most noteworthy at any point recorded. A huge expansion in the recurrence of (moderate) storm floods can be shown genuinely for the North Sea and the Baltic. Also, along the Baltic coast the drawn-out records show a critical increment of storm surges.



### Flooding Zone and Flood Defense Line

The Hamburg city was flooded in 1962, after that significant flood protection measures have been used to save the city from floods. After the natural disaster and floods affecting the Hamburg's major coastline region the city has developed dikes, horizontal slopes, constructions and reinforcing them to make them stand against the floods. In the mid-90s, Hamburg's flood

protection program was started to raise the height of retaining up to one meter around the coastline regions. Much of the Hamburg's area is redeveloped and the buildings near coastline are surrounded by dikes to protect them against the flood. Above is the 'flood wall' of Hamburg, protecting the city where it meets the river. Although, 270 km<sup>2</sup> of (36%) of city area is at risk.

## FLOOD PROTECTION WALL

Hamburg has very high flood protection level but the areas located near the Elbe has a very risk of being flooded during a storm surge. Approximately half of the Hamburg's area is declared as flood prone. The areas near the coastline would be flooded if there was no flood control measures. While Harbor is tide-exposed, the urban areas are under the protection of the dykes, sluices and flood barriers. Due to the climate change and average sea level rise the maximum water level rise of around 20 cm is expected in Hamburg by 2030. This increase is unpredictable by the end of the century therefore Hamburg has adopted flood protections for maximum sea level rise. Because of the various water bodies in Hamburg, there is also a risk of inland floods. The areas which are described as the high chances of flood events and huge anticipated harms from flooding are

attributed to Alster, Osterbek and Wandse. Some areas like Berner Au, Ammersbek are situated in the district Wnadsbek. While some portion of the Alster is situated in Hamburg-Nord as well as the stream Tarpenbek. The last one is situated at the boundary to Eimsbüttel. Here, the creek Kollau is another stream affected by flood risks. In the southern part of Hamburg, Bergedorf faces the risk of flooding due to the rivers Mittlere Bille, Obere Bille, Dove Elbe, Gose Elbe and the creek Brookewetterung. In Harburg, there are the Este and the Falkengraben.

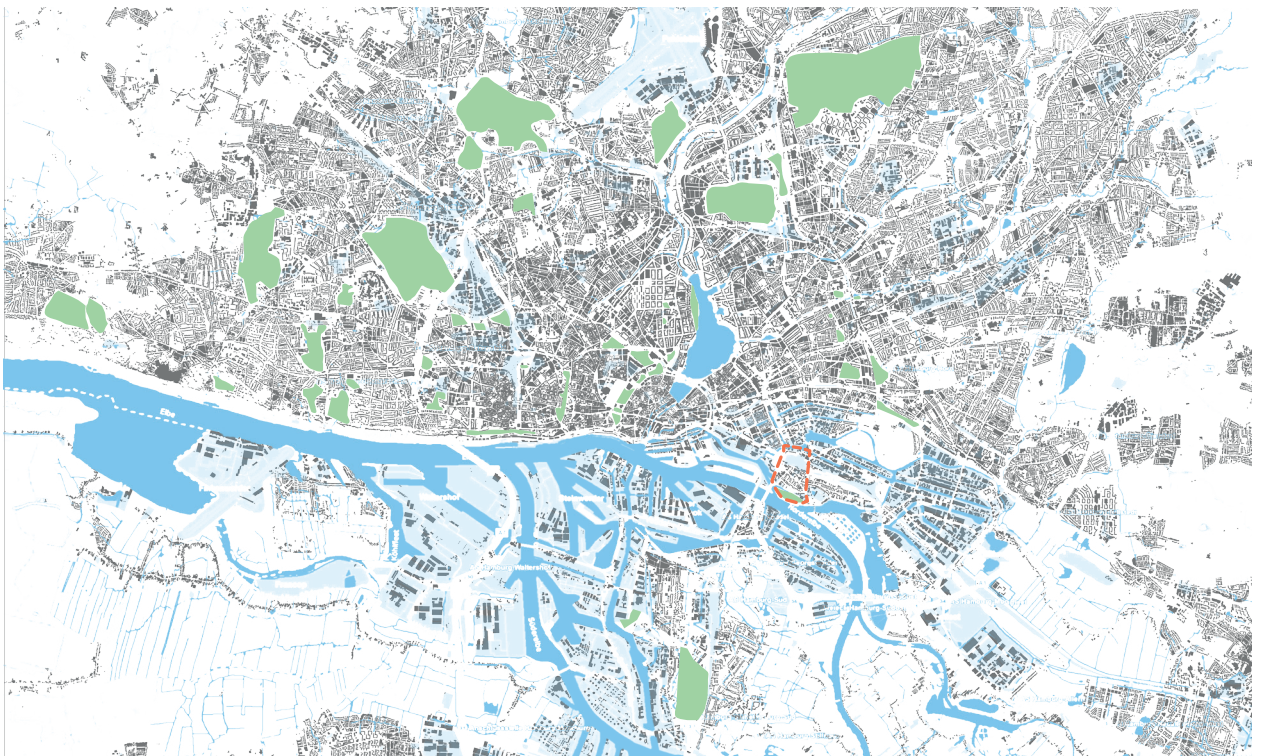




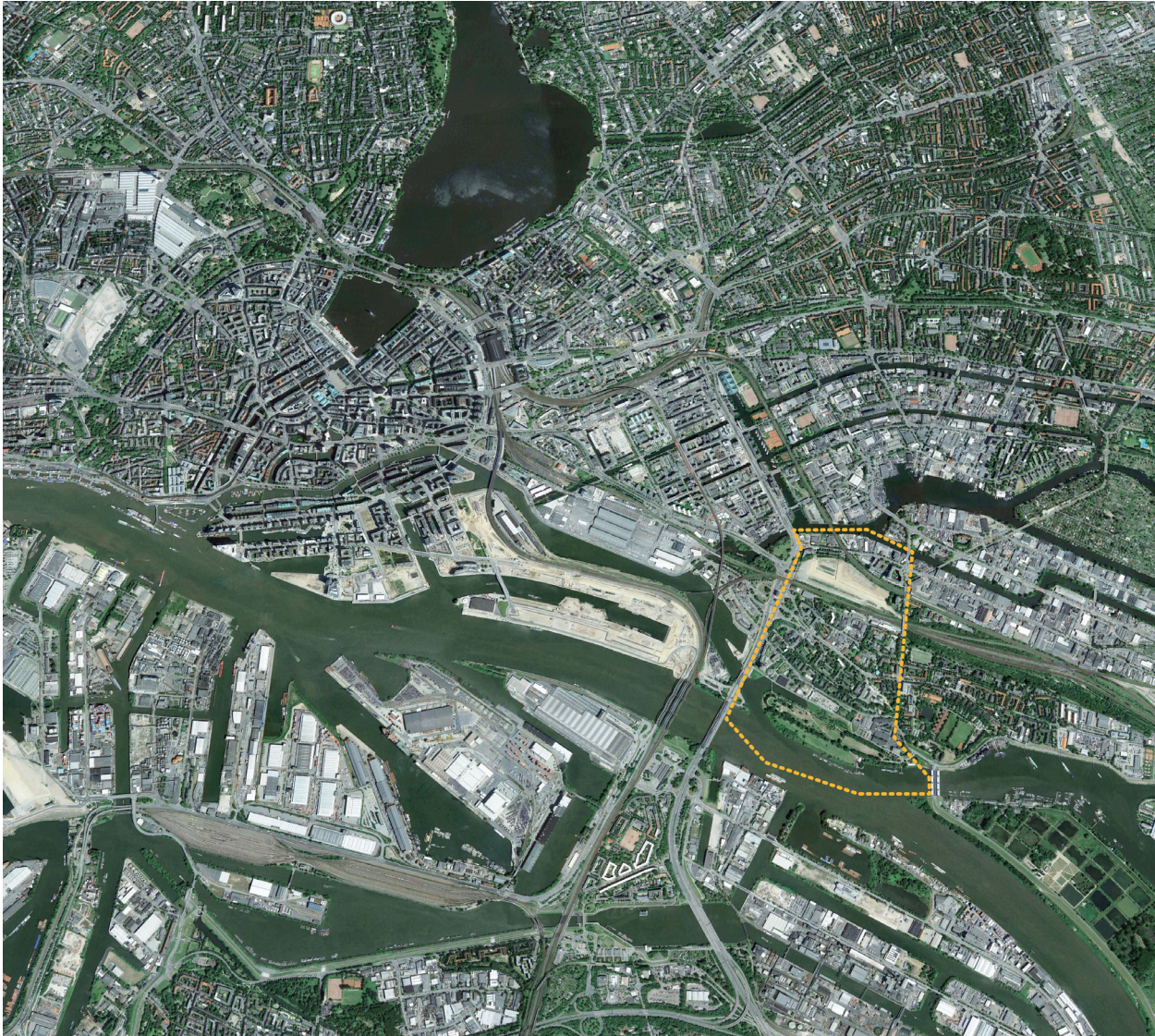
## GREEN AREAS

Green areas of Hamburg are a significant piece of the townscape which includes its parks, urban landscape, street trees, squares and riverbanks. These recreational places could be found right in the city centre. Green blends with the inescapable water describes the city's environment. This could surprise visitors and inhabitants value it as a quality of life. Hamburg has devoted much effort to maintain this quality, by reducing the footprint of developments, by designing new parks and by taking care of street trees. Hamburg's unique geographical location at the coastline of the Elbe,

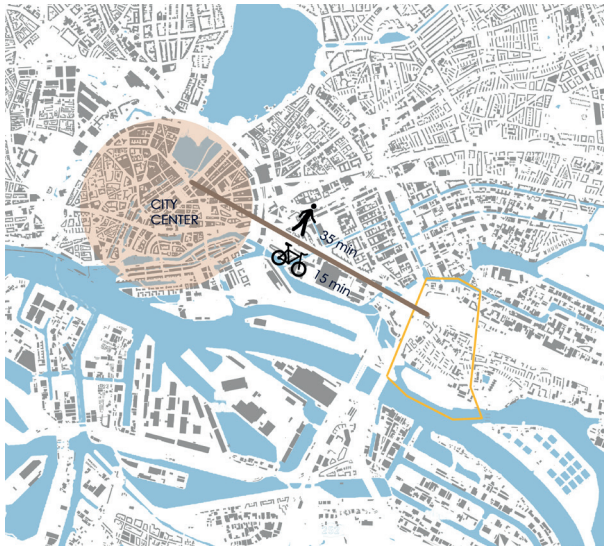
and the impact of this flowing stream have made habitats with tremendous biodiversity. Wetland and floodplains in the river valleys remained generally intact, because they were considered unsuitable for development for a long time. Fields and forest are situated in northern and southern parts of the city. This important natural legacy is uniquely safeguarded for people in the future to appreciate: Eight percent of Hamburg's complete region are designated nature reserves. This is more than in any other German federal state and the city still hope to designate further areas.



# AROUND THE SITE

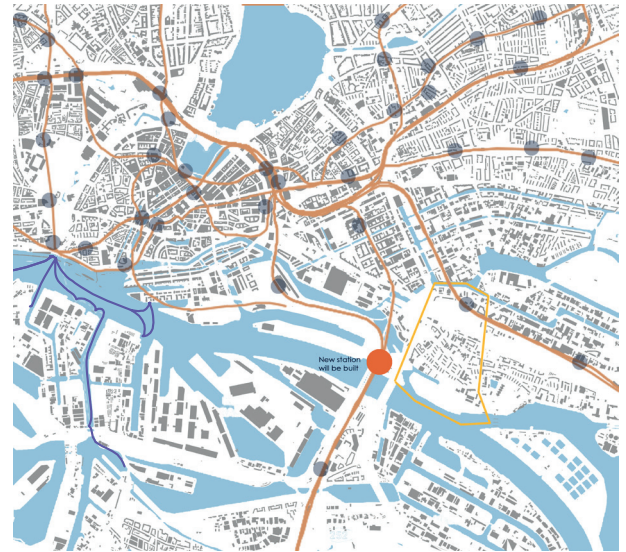


## SITE TO CITY CENTER



Distances

The area is located close to the city center with possibilities for biking and even moderate walking. It would take around 15 minutes to cycle to the very core of the city center and 35 minutes. This proximity to the center gives great possibilities to the site for further development.



Railways and Ferry Lines

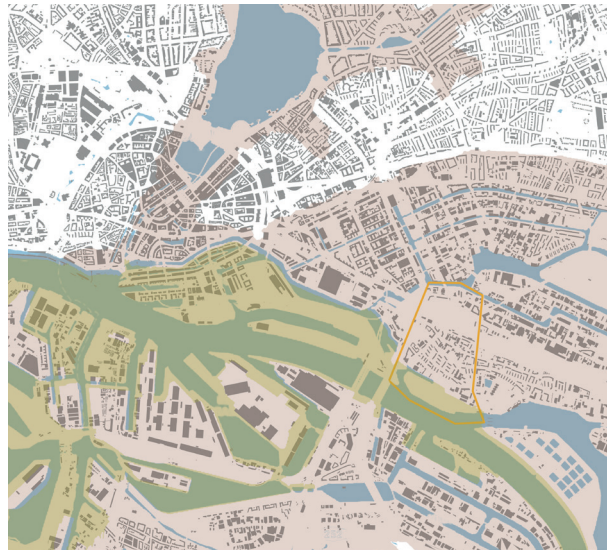
Hamburg city is well connected with the railways, although the area has only a line with a station in it. There are plans by the municipality to have a new station on a different line close to the opposite site of the existing station just outside the area. In the current situation there is no ferry line which stops by the area even though ferries are a good part of the transportation in Hamburg.

# FLOODING AROUND THE SITE



1962 Flooding

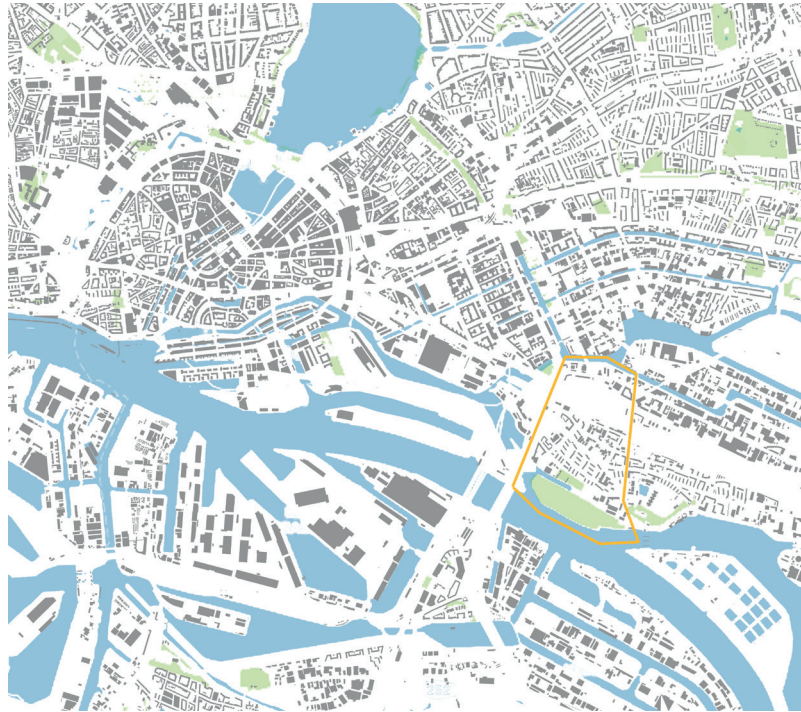
The flooding event that occurred in 1962, which had great impacts in Hamburg, affected the site as other areas around Elbe. According to the studies for affected areas, more than half of the site had water on the surface.



Storm Surge Normal and Extreme Events

Based on a study projecting future floodings, there are two scenarios forecasted, normal storm events and extreme storm events. The study points out for these different projections, part of the site will still get flooded (shown in green) in normal storm events and all site will get flood in extreme storm events.

# GREEN AREAS



## Green areas

Green areas around the proximity of the site are rather limited and smaller comparing to the other green areas in the whole city. Denser built environment in the city center and closer neighborhoods would benefit from more green areas where residents could enjoy outdoors and recreational areas. Although the green peninsula located in the area seems one of the bigger green areas in this scale, lack of recreational activities and weak

connections to the area make it less known and used. This analysis is a clear base for the vision of the development of the area in the future.

# SITE

The site in focus from satellite imagery shows that most parts are surrounded by the river, there is quite spacious unused area which used to be a railroad yard.

Streets, built and natural environments clearly shows the existing features.





Ground Floor



Upper Floors

### Land Use

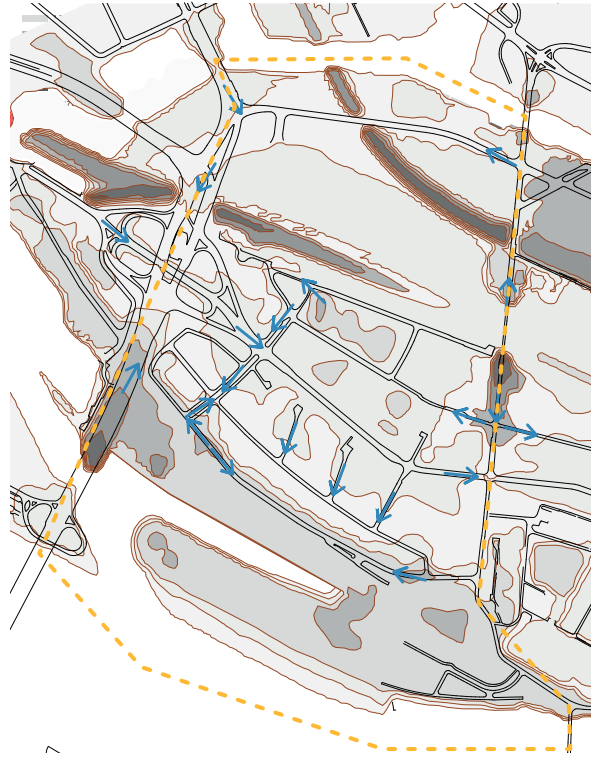
The area consists of a wide range of different functions from though these are mostly in as groups where residential areas are mostly near each other, with a smaller industrial zone and a commercial area. In addition to these, services and offices are part of the area close to the school area for younger children. Most buildings have same functions in the upper floors as in their ground floor except some with

commercial use.





Existing Floors



Upper Floors

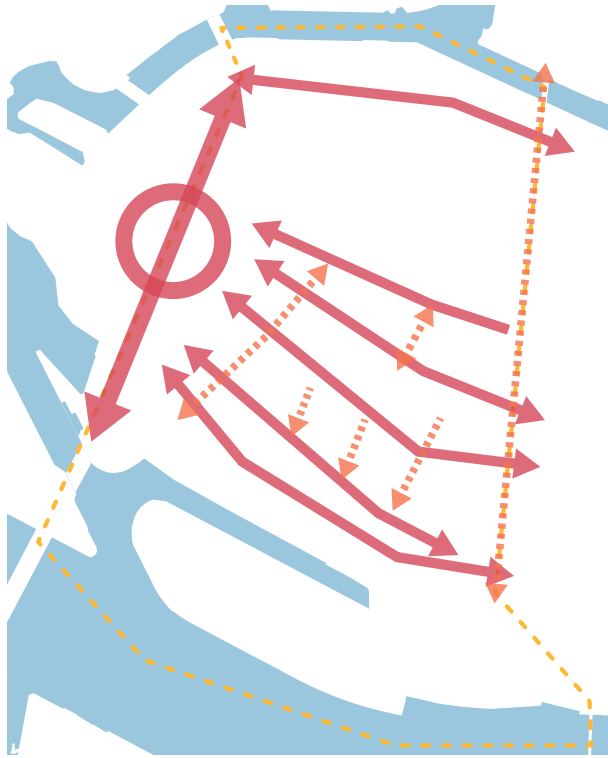
### Floors Analysis

In the existing situation most of the buildings are with 5-6 floors which are residential buildings. Lower buildings are where the industry/education functions are located, and one of the highest buildings in the area serve as a hotel and the other as offices. There seems a height raise around the main street in the area near commerce.

### Topography & Water Flows

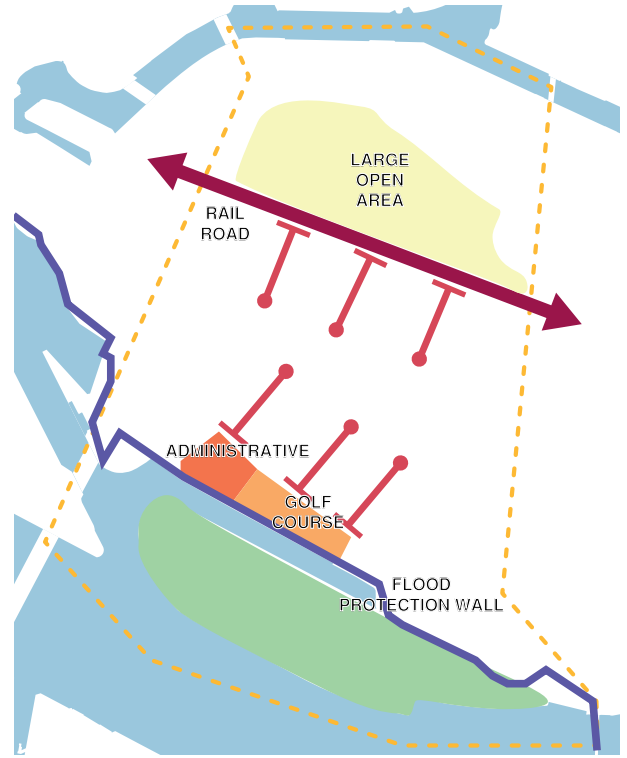
When the topography is considered, even though most of the site could be considered almost flat, there are still mild changes. The highest points are for bridges for roads or railways. The arrows are to represent the water flow on hard surfaces as roads. The area has a poor topography in the case heavy rains and water management system is not sufficient, surface water would not find a way to be disposed from the area.

# PROBLEMS



Connections

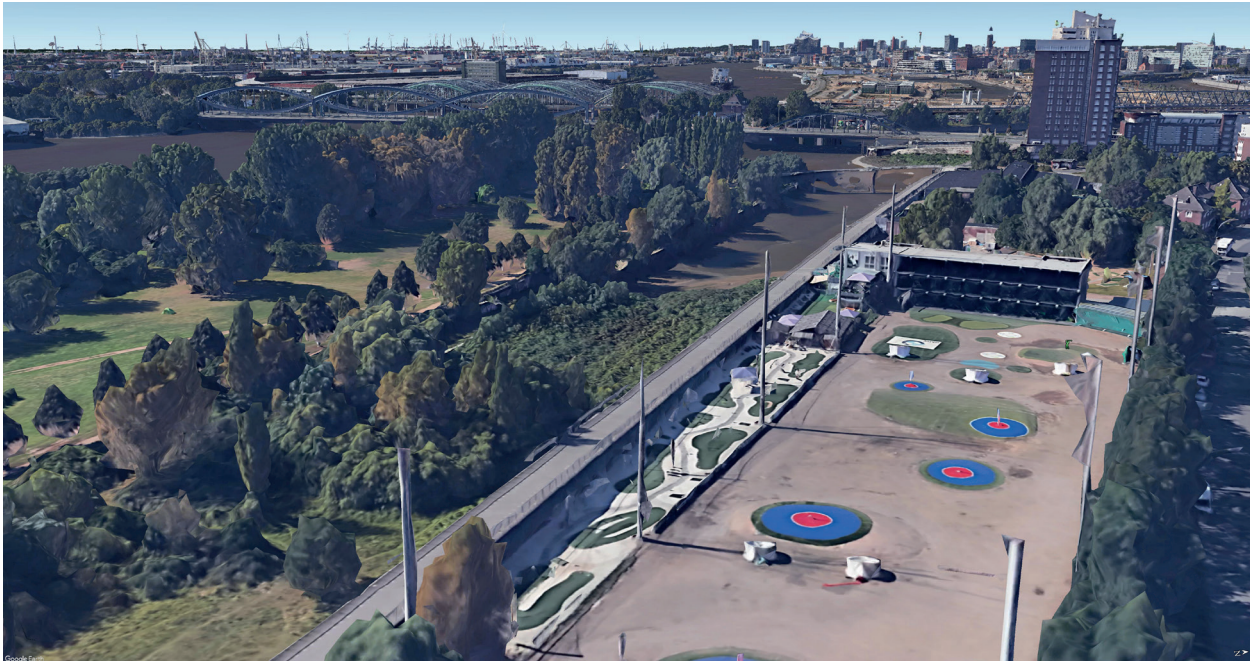
In the existing situation there is a large road junction which brings heavy car traffic, splitting the area from the city center and making it difficult for pedestrians and cyclists to roam around within the area and to/from the city center. In addition to the junction, the roads and pedestrian ways are more lined as west to east with lacking or weaker north to south connections which leads to water fronts and the green peninsula in the south of the area.



Barriers

There is a large open space with a potential for development although it is not accessible from the south because of the railroad. Additionally, the functions in the south of the area as the administrative building and the golf course together with the high flood protection wall hinder the access to the waterfront and the green area.

# PHOTOS



Riverside in the south of site, Source Top: Google, Bottom: Author



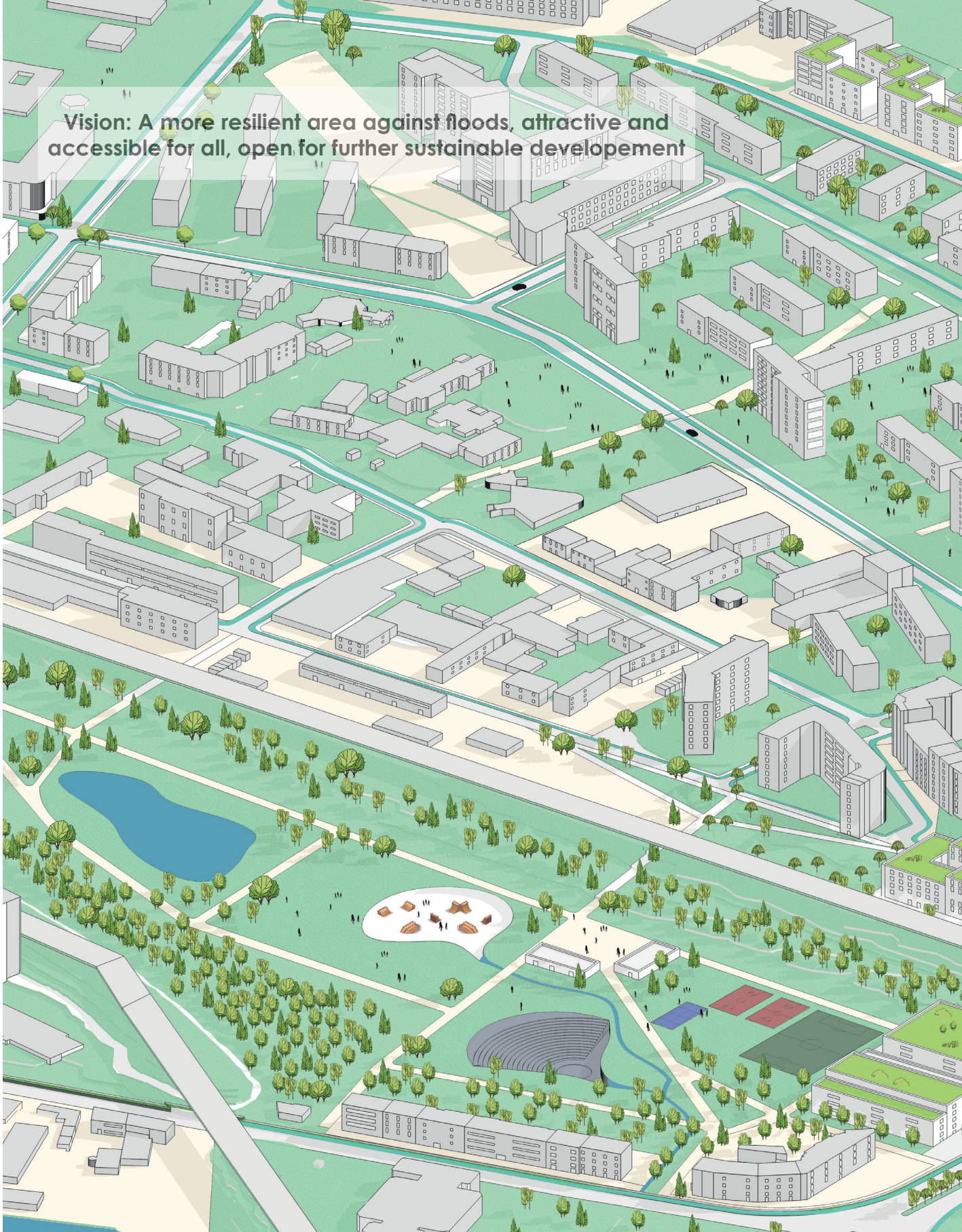


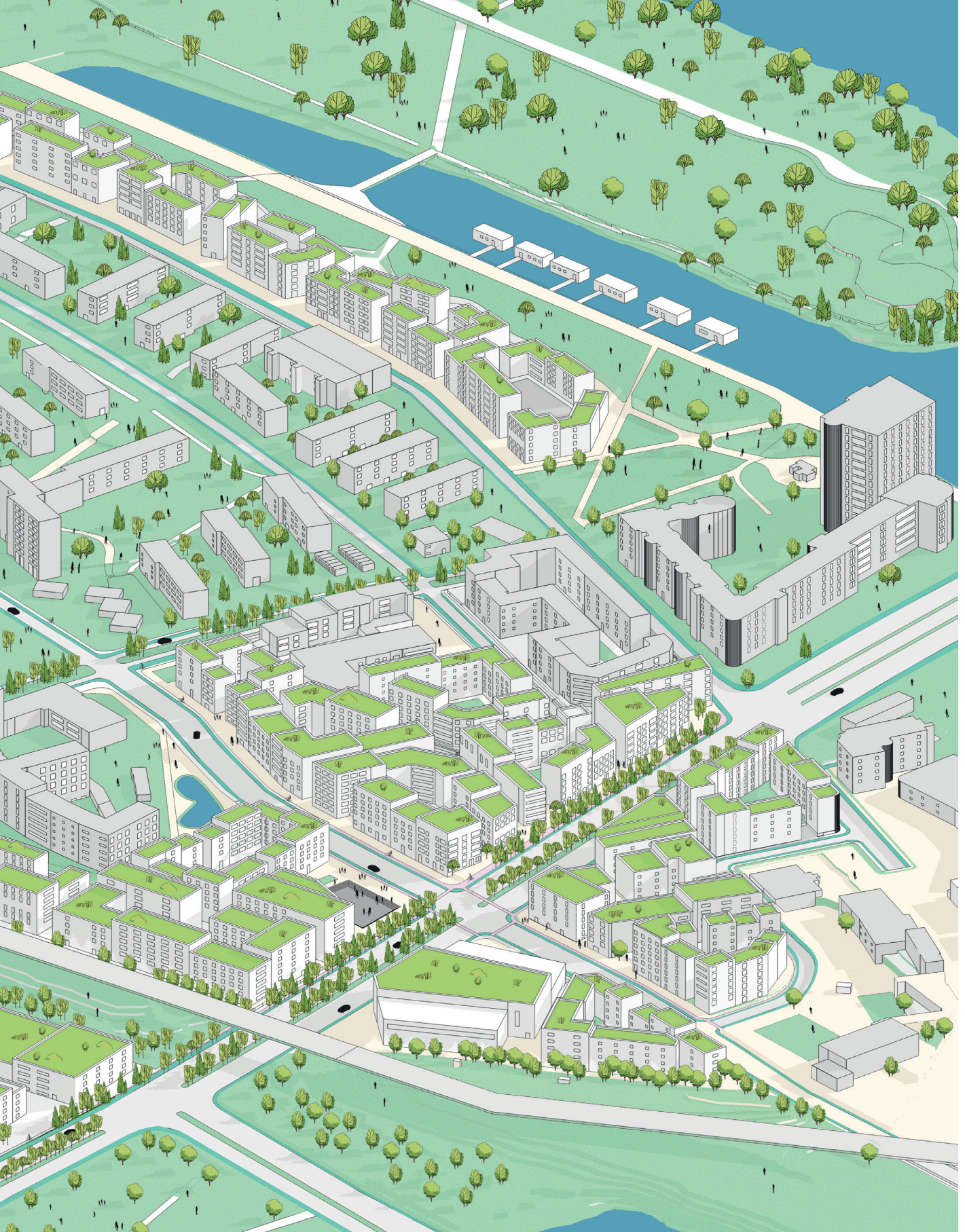
Top: Void area, Source: aufwind-luftbilder.de Bottom: Road Junction and the site, Source: euroluftbild.de/Gerhard Launer



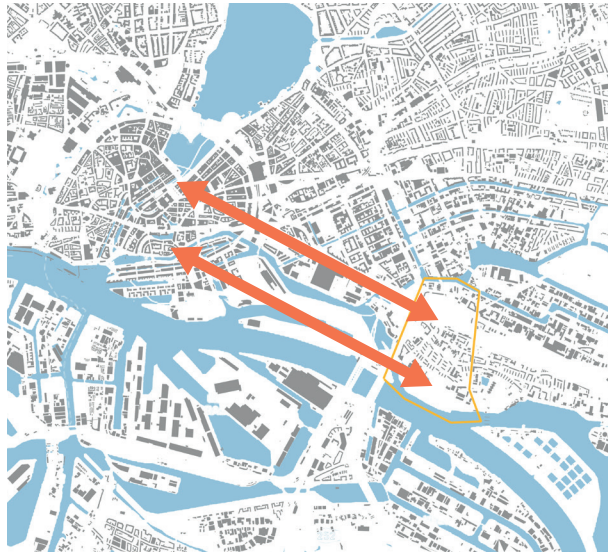
# PROPOSAL

**Vision: A more resilient area against floods, attractive and accessible for all, open for further sustainable development**



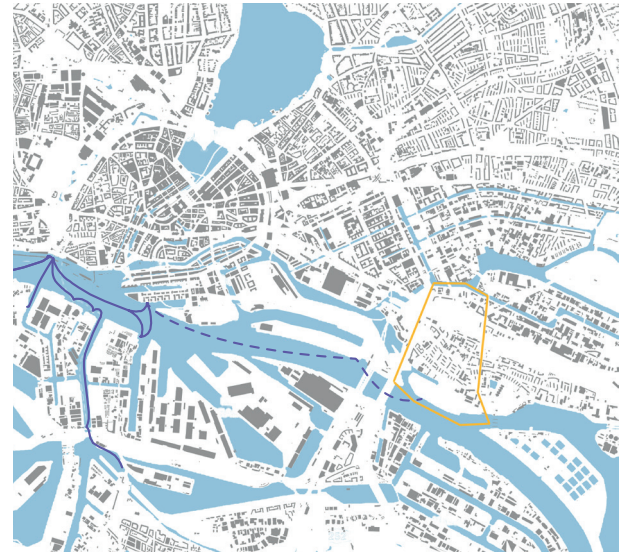


# STRATEGIES



## Connect With The City Center

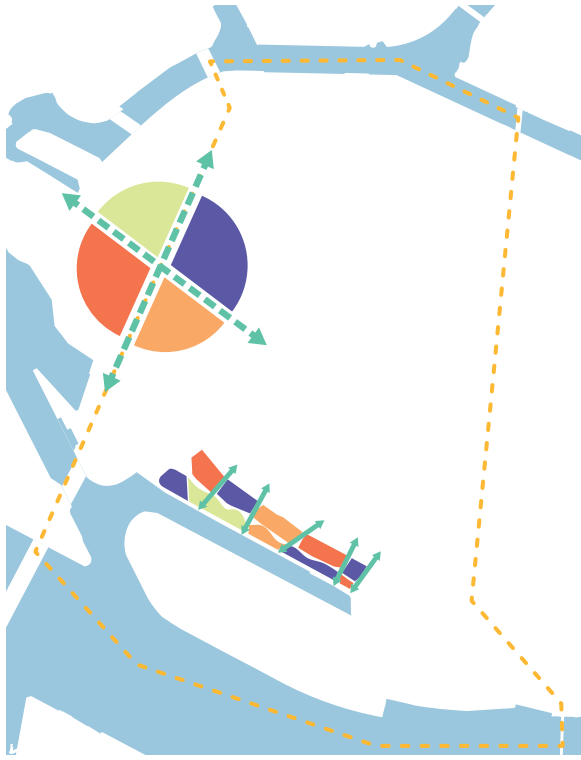
The site has a great potential with being close to the city center, which can create possibilities for future development. One of the main strategies is connecting the city center and the site by making the area more accessible, reducing the barriers, and creating more ways to be used such as ferry line for easier reach.



## Extend A Ferry Line

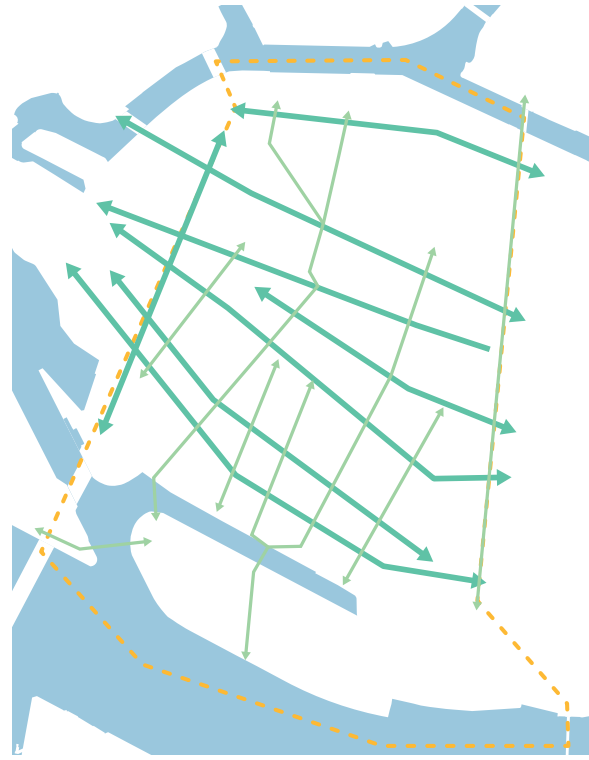
Even though ferries are a part of the transportation both for tourist and locals to get around Elbe River, the lack of connections to the eastern part of the city was clear. One of the lines is planned to be stretched out further and making a stop within the area. A new ferry dock is planned to be in the south to make the connections easier and to attract more people into the area.





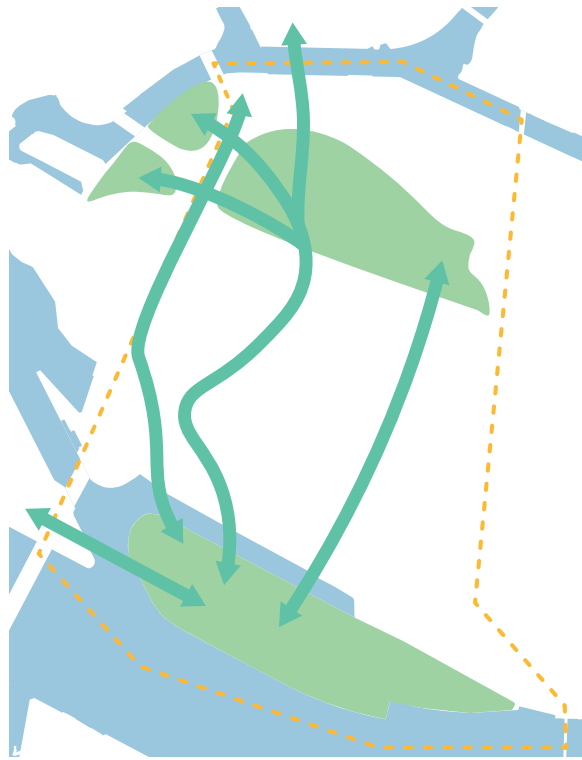
**Break Down Barriers And Activate**

As previously mentioned, there were connections barriers to and within the area. Strategies are focused on firstly breaking down the major road junction issue and reclaiming the area for other purposes than serving for vehicles. The junction is now a leveled intersection with more pedestrian and bike friendly streets and the gained space from this transformation is planned to have mixed use around for a more livable space. South of the area where the access to



**Better Connect Within the Site**

the river was limited has a change of land use, with better connections and a new program to introduce new ways of dealing with the flooding instead of the city's approach of the "flooding wall". West to east connections were stronger, and the new strategy focused on making the connections north to south to be equally strong through new bike lanes, pedestrian ways and green corridors.



**Connect Green Areas**

A new green area is introduced in the Northern part where in the past it was used for railway yard and empty in the existing situation. This new area is planned to connect the existing areas around and the one in the south through green corridors, stretching out to surrounding neighborhoods.

- 1-2 Floors
- 3-4 Floors
- 5-6 Floors
- 7-8 Floors
- 9-10 Floors
- 11-17 Floors
- Proposed



**Proposed Floors**

The new functions in the area has similar heights as the existing buildings but with varying heights within their surround. Riverside area buildings are planned to have lower roofs to allow the residents in the back to enjoy the views. The new central area has varying office/university building heights with residential around.



**Proposed Land Use - Ground**

The new areas as riverside, main area and park area are located to activate their surroundings. Riverside area is expanded with residential use, and new building include commerce and services as shops, cafes, an art gallery, and a small library.

Main area where the roads are transformed into a more livable space is now with mixed use buildings as university, cultural center, offices,



**Proposed Land Use - Upper Floors**

commerce and residential. Park area is activated with a sports building and a library.



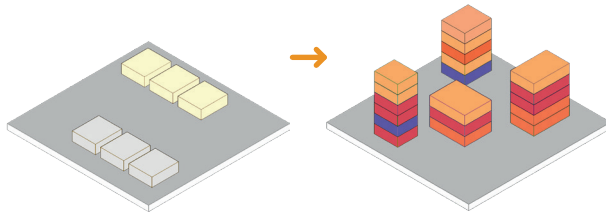
# MASTERPLAN

Masterplan is designed to focus on solving different issues while providing sustainable and on point solutions. The riverside which previously was not easily accessed because of the use in the area and the general dike situation, is now activated with a new vibrant area of mixed use and the "wall situation" is replaced with better working green space/roof which serves as a barrier for situations when the water level rises.

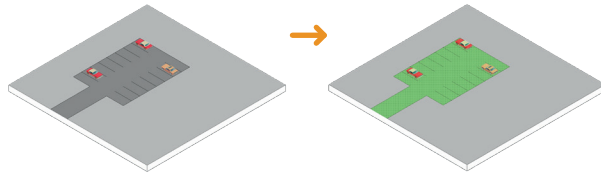
Area where main roads intersect and become a problem for accessibility for pedestrians and cyclists is now

transformed into a mixed-use area by reducing the sizes of the roads and slowing down the traffic for more pedestrian and bicycle friendly environment. The space gained by this reduction is now a compact intersect which is used for new development within the area which will also be beneficial for the city of Hamburg. While residential and commercial uses are majority, there is also a cultural building and educational buildings as university.

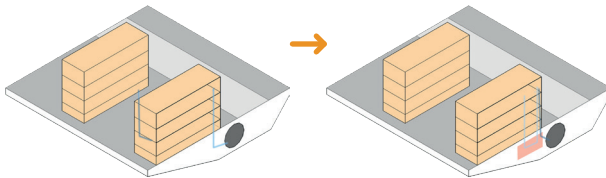
# TOOLBOX



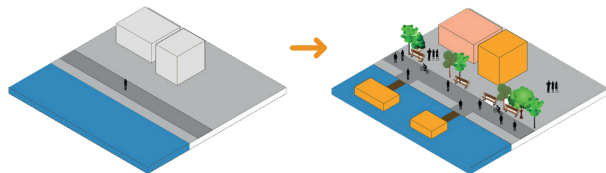
Mixed use to vitalize areas



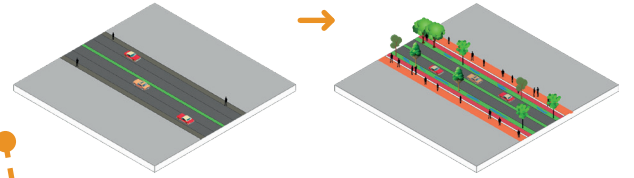
More permeable space



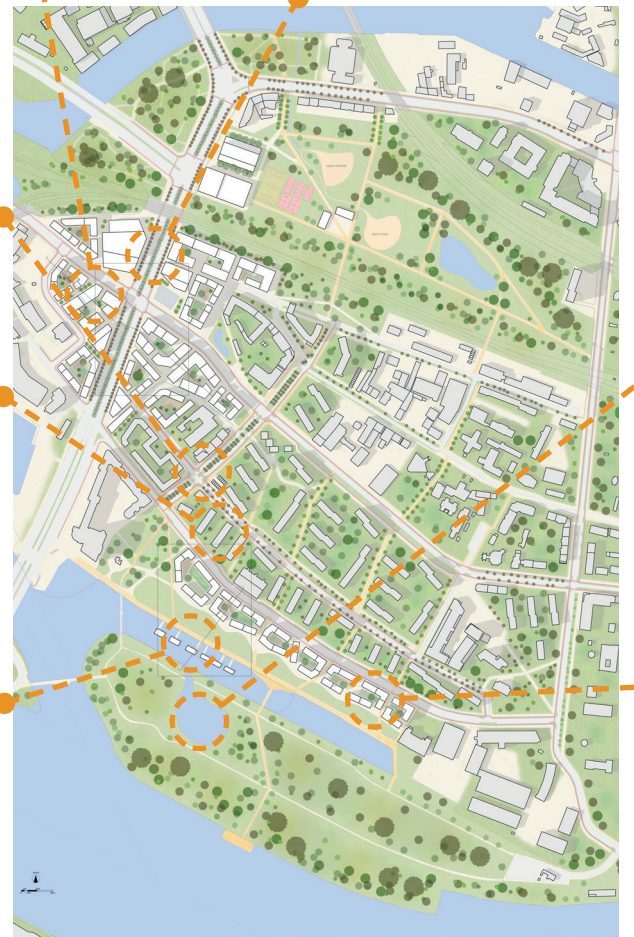
Recycle grey water

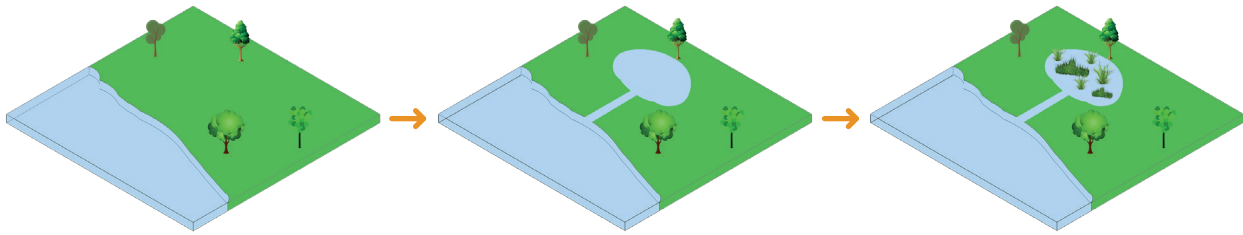


Activate the river front



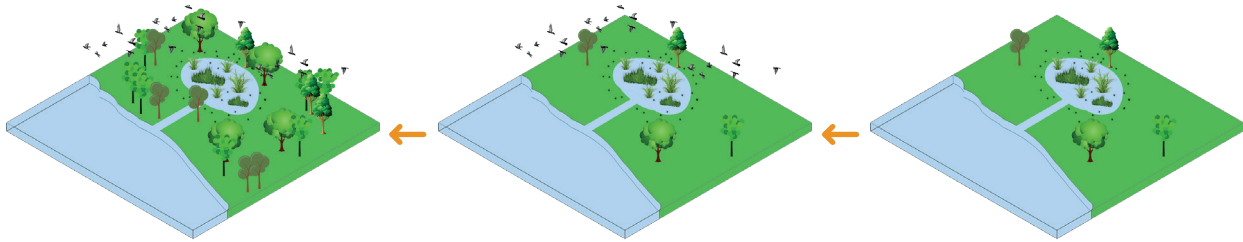
Street Changes: Bioswales for better flood resilience and bike lanes for better connections





Create wetlands

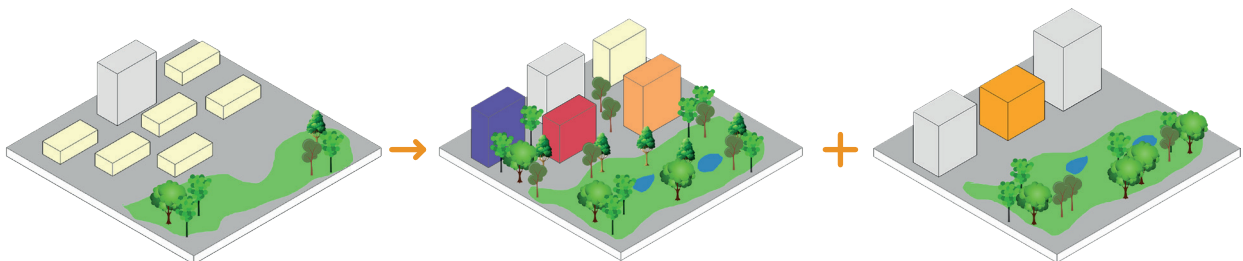
With planting, start new ecosystems...



which will bring more seeds and more vegetation

and then birds

...which will attract insects



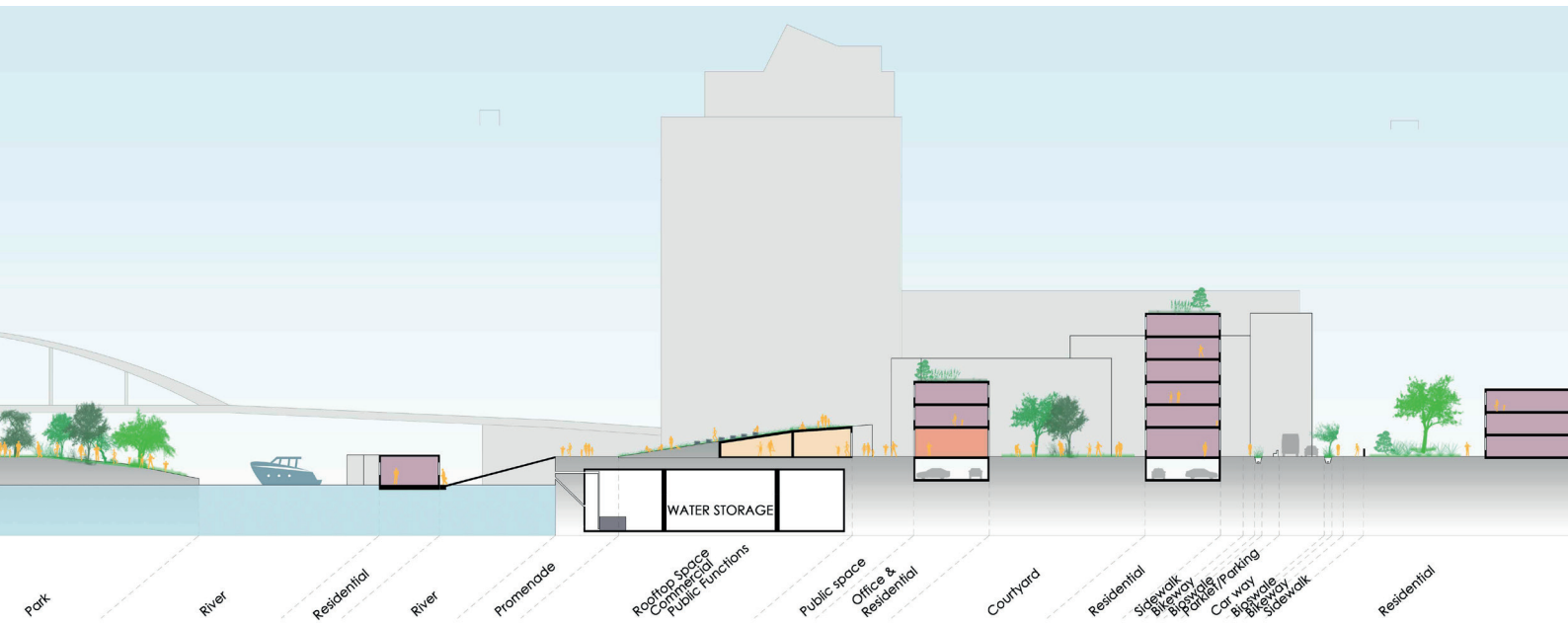
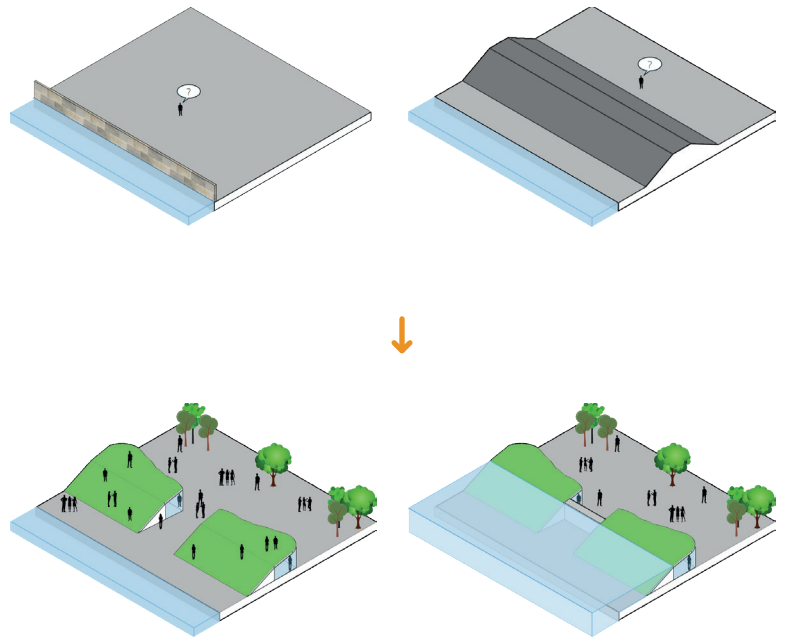
Prevent sprawling by densification and fill in with more green space



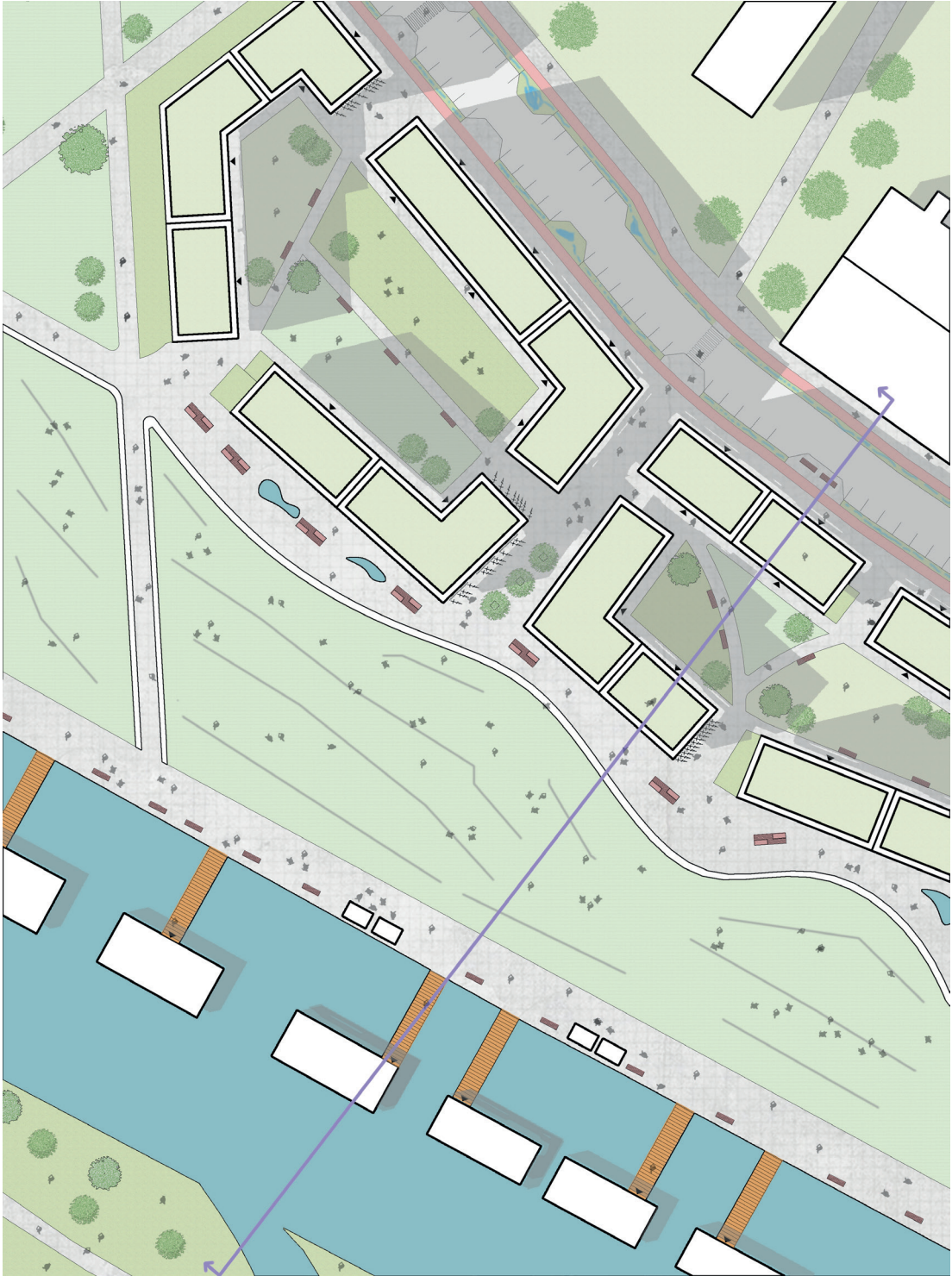


# DETAILED: RIVERSIDE AREA

Riverside is now more accessible and more attractive with new functions. Instead of the wall like high ground between the river and the land, tilted slopes covered with green and moveable gates in between are introduced which blocks the water in heavy rain situations. A new Water Storage is implemented under ground, which can gather the water in extreme events and release it back when the river is low. New residential buildings with variable heights and floating houses are proposed to meet the need for more residential areas.



# Detail Plan for Riverside



Detail Plan for New Development Area

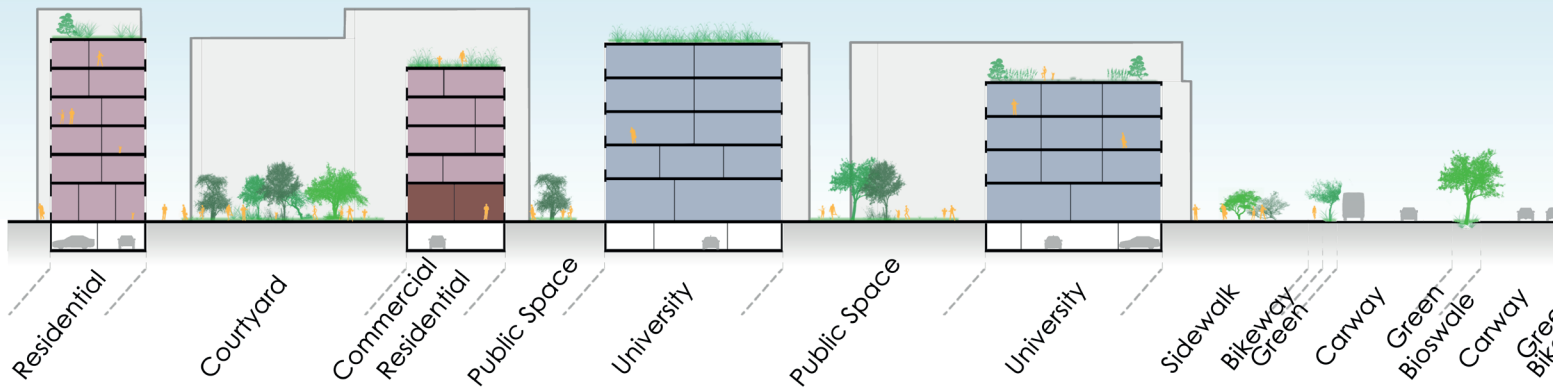


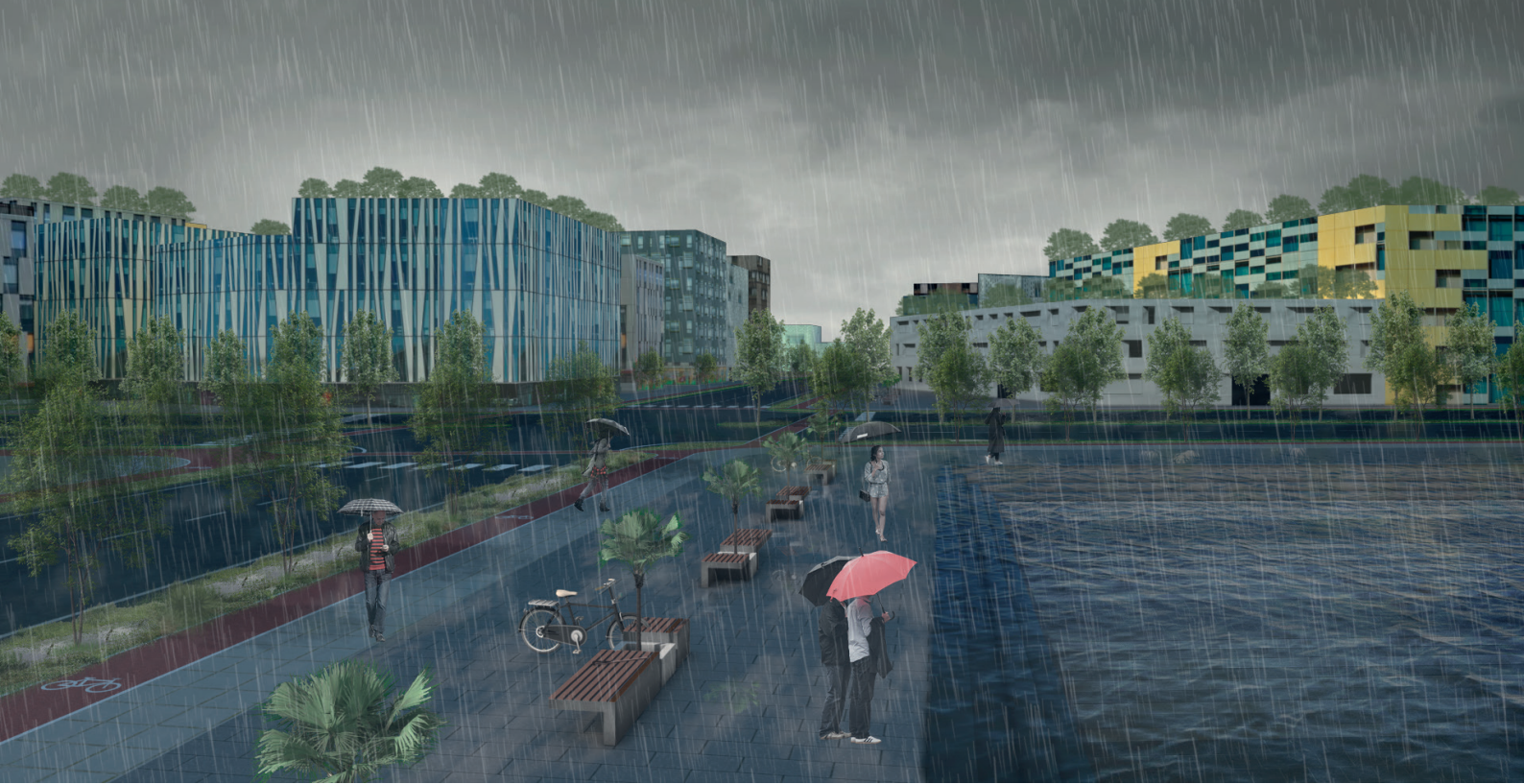


## DETAILED: MAIN AREA

In this area where large roads used to intersect, a more bike and pedestrian friendly approach has been followed. The space taken for car traffic is now reduced and the gained free space

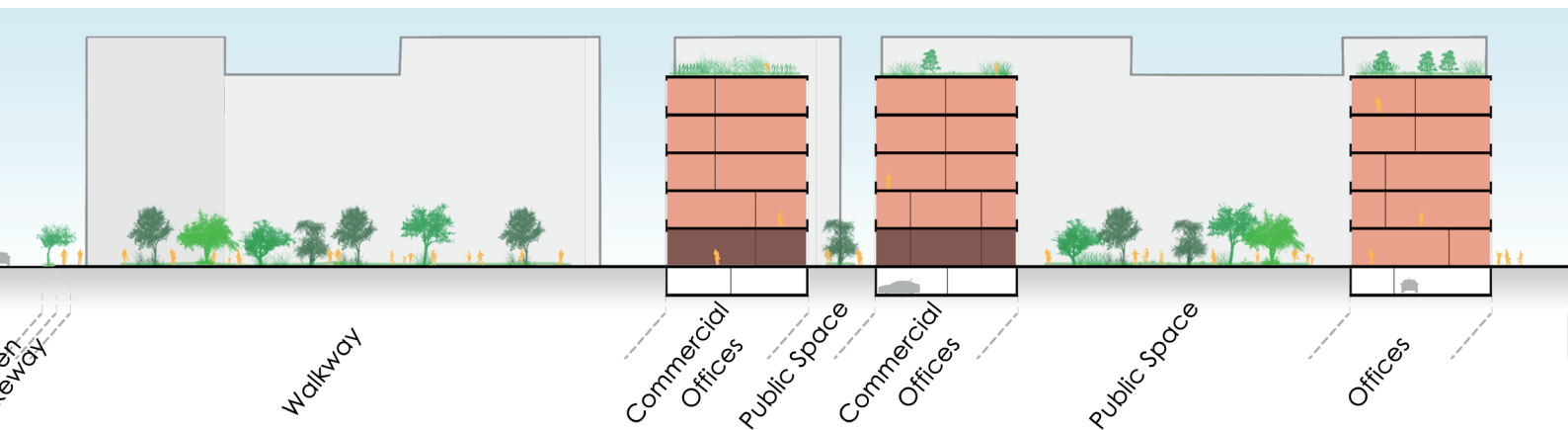
is transformed into a more attractive place with better connections to the city center. A green corridor is added on both sides of the street and the median to serve the green connections strategy. New functions as a university and cultural buildings where events and art activities could be organized





are planned. A mixed-use program has been followed to include offices, commercial and residential areas. Road sections are now including better organized sidewalks and bike lanes to strengthen the connections. In addition, strips of bioswales as part of the strategies to cope with flooding are

introduced to help with reducing the flooding risk by absorbing high levels of water. A new plaza is planned to be in the area for the users of surrounding functions and visitors to the site. This new plaza is also designed to be lower ground to help in the case of heavy rains to gather excessive water.



# CONCLUSION

The starting point of this thesis project were the questions: What could be done to design areas for making them flood resilient? How can sustainable urban design be adapted to provide flood resilience while transforming an area into a more livable space? Based on the research made, analysis of the area and its surrounding and the site visit strategies have been proposed to answer above questions.

Transforming an area in such ways to cope with the flooding in a sustainable approach, through solutions against excessive storm water and tides, while making the area a more livable space for the residents and meeting the needs of the city for further development. Newly introduced green area, mixed-use programs, open spaces, bike, pedestrian, and green connections have been aimed to solve the problems and use the potential of the site.

The new ways of solving the issues with water is a new approach for Hamburg, where in the existing situation dike type walls is the main tool against the flooding. This new approach has been aimed to be a guideline to further transformation of other areas in Hamburg, while still being a problem-solver for flooding but also being a sustainable way of keeping and developing the public

features, and placing "human" factor in the focus.

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# FLOOD RESILIENCE 2.0

Sustainable Urban Design  
Adaptation For Flood  
Resilience In Hamburg, Germany

Master Thesis Booklet

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