URBAN RIVERFRONT ZUTPHEN

LINK BETWEEN THE RIVER AND THE PUBLIC URBAN SPACES

P5 REPORT

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PREFACE

This master thesis is written for the graduation project ‘Urban Riverfront Zutphen’. The project is done for the master in Urbanism at the faculty of Architecture at the Delft University of Technology. The project is involved with the ‘Delta Interventions’ studio. This studio focuses on delta areas where high density building faces a potential threat from water damage. Due to the effects of climate change, technical innovations and new insights in urban design, there are opportunities to create a new generation of spatial design. The studio targets these new ways of designing and considers the effects they can have in the delta area (www.deltaintervions.com).

The master thesis describes the results of the whole project and the steps that have been taken to obtain these results. The first part describes the framework that is used as a (theoretical) foundation for the project. In the second part attention is given to the different research that has been done and the results from this research that are relevant for the design. In the last part of the thesis, the design of the location is described, followed by a retrospective reflection upon the whole graduation project.

I would like to express my appreciation to my mentors Han Meyer and Steffen Nijhuis who guided me through the whole process. I also would like to thank my family and friends who shared their insights and supported me during the project.

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AMBITION

Zutphen is a middle-sized city with 50,000 inhabitants in the east of the Netherlands, in the province Gelderland, close to Apeldoorn and Deventer. The city is located on the east side of the river IJssel. Most urban growth took place on this side of the river. The small urban settlement on the west side of the river is the neighborhood of Zutphen, called 'De Hoven'. Zutphen was established around 900 A.D. and as a former Hanseatic city has a rich history, which is clearly reflected in the current medieval center. Another quality of the city is its location along the IJssel, a popular river for tourists, day trippers and nature lovers. Currently, plans are developed for urban growth along the river, in the former industrial area 'De Mars'. At the same time it is necessary to find a solution for future water problems. As an urbanism student, I think it is interesting to investigate if it is possible to combine these different spatial planning projects and try to improve the spatial relation between the historic city center and the river. The goal is to make Zutphen waterproof for the future and also to give the city opportunities to benefit from its urban qualities.

Fig. 0.1: The city of Zutphen and its location in the Netherla

River IJssel

The river IJssel starts in Arnhem and ends 125 km north in the IJssel lake. It flows through the provinces of Gelderland and Overijssel. Due to a small altitude difference in the landscape, the IJssel is a quiet, meandering river. The water finds its way through the landscape and flows in large curves and loops. In the outer- and inner curves arise different landscapes, each which different characteristics (“IJssel, handreiking ruimtelijke kwaliteit”, 2007). These natural forms and landscapes are relics from the past. Construction of groins and dikes has decreased the dynamic of the river. These interventions were necessary for commercial shipping. They guarantee a certain flow- and depth of the river. The IJssel is also used for recreational shipping, thanks to the diversity in landscape and the presence of historical cities, such as Kampen, Deventer, Doesburg and Zutphen. The river is a branch of the Rhine: this means that the IJssel has a large catchment area. During normal situations the IJssel discharges one ninth of the Rhine water. In cases of high water the Nederrijn can be (partially) closed; in those cases more water will flow through the IJssel. (“Projectorganisatie: ruimte voor de rivier”, 2007).

nds. (Source: Google Earth)

PART I
FRAMEWORK

In this part the (theoretical) foundation of the graduation project is explained. It focuses on the problem statement, the aims of the project, the research questions, the social and scientific relevance and the structure of the research- and design process.

PROBLEM FIELD

To put the case of Zutphen as a river city in a wider perspective, the general problems of the Dutch river cities are described first. In the second part the focus is on the location and the specific problems that arise there.

Urban river areas

Due to climate changes, the water level in the Dutch rivers will (almost undoubtedly) rise in the next century. The current water management and flood defence systems are not able to deal with this increase in river discharge. Not only has the probability of a flood increased, but the consequences of this are also more serious. Due to economic development and the population growth in the last century, a flood will cause more economic and social damage (Stalenberg, 2010). The Delta committee (2008) recommends measurements in most parts of the Dutch river landscape.

Raising the height of the dikes and obtaining control over the rivers is no longer the way to do it; this will only lead to higher water levels and greater risks. The new policy is to give more space to the dynamics of the rivers, with the aim to lower the water levels (“Projectorganisatie: ruimte voor de rivier”, 2007). The ‘Ruimte voor de rivier’ programme created a set of hydraulic interventions, such as lowering groins, making bridgeheads permeable, digging out floodplains, shifting dikes back and constructing flood bypasses. The Dutch national government assigned these solutions to certain areas of the river. In these areas, local and regional governments can link these interventions to housing, recreation and waterfront development

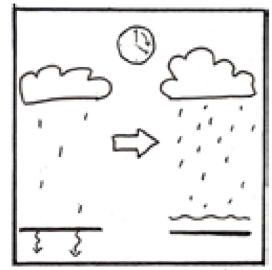


Fig. 1.1: More extreme rain falls.
(Map made by ‘Studio Delta Interventions’)

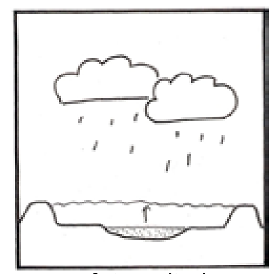


Fig. 1.2: Increase of river discharge.
(Map made by ‘Studio Delta Interventions’)

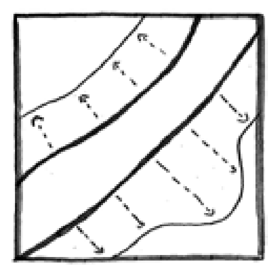


Fig. 1.3: More space for the rivers.
(Map made by ‘Studio Delta Interventions’)

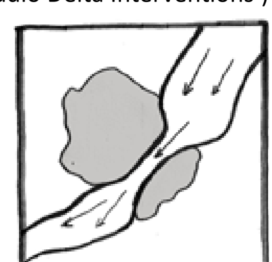


Fig. 1.4: Urban bottlenecks.
(Map made by ‘Studio Delta Interventions’)

Fig. 1.5: Locations for ´Room for the river´ interventions. (source: www.ruimtevoorderivier.nl)

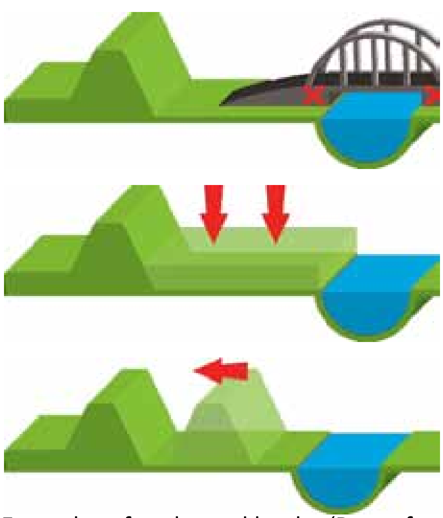


Fig. 1.6: Examples of tools used by the 'Room for the river programme. (source: www.ruimtevoorderivier.nl)

("Projectorganisatie: ruimte voorde rivier", 2007). So the new policy not only pays attention to water safety, but it also tries to increase the spatial quality of the river itself.
Especially around urbanised areas, this causes problems: there is not much space to implement suggested hydraulic interventions, because of urban developments in the water meadows and floodplains. These urban bottlenecks are causing extra high water levels, so at the places where interventions are most needed it is also the most difficult to intervene. Raising the height of the dikes on urban riverfronts is also difficult. In most cases there is not much space for flood protection structures. These structures will also destroy historical urban areas and the spatial relationship between the river and the city (Meyer et al., 2010).
At the same time, river cities (the inhabitants and policymakers) have developed a new interest in rivers. 'Space only becomes place when it is given a contextual meaning derived from cultural or regional content.' (Trancik, 1986: p.112). Cities realise that the river is part of the cultural and regional context surrounding them. Huisman (2006) states that water in the city contributes to the spatial quality, which results in an increase in livability and attractiveness for inhabitants. Ensuring an open relation with the water can be used as a kind of city branding, which makes it economically attractive. When water management is also taken into account, new interventions will lead to a more sustainable city.

The task for the future is to develop a comprehensive approach that improves the flood defence system and creates high-quality urban development and attractive landscapes (Meyer et al., 2010). Civil engineers and urban- and landscape planners have to work together. ‘Once again urban planning, landscape design and hydraulic engineering will have to deal with each other. This means new problems, new opportunities as well as possibilities for the spatial design of city and country.’(Hooimeijer et al., 2005: p.15).

River city Zutphen

Near Zutphen, measurements in the river IJssel have to be taken to keep the city safe in the future. For the short term (up until 2015) shifting back two dikes north and south of the city will be sufficient. These interventions will cause a lowering of the water level of 30 centimeters (“Plan IJsselsprong”, 2009). Unfortunately, this will not be enough for the long term (2050); more room for the rivers is needed or the dikes need to be heightened. In the urban bottleneck it is difficult to find space for the river. Raising the height of the dike on the urban riverfront is possible, but it will destroy the spatial relation between the river and the city. One of the good qualities of Zutphen is its location next to the river and with water defence interventions there will be a significant loss of this advantage.

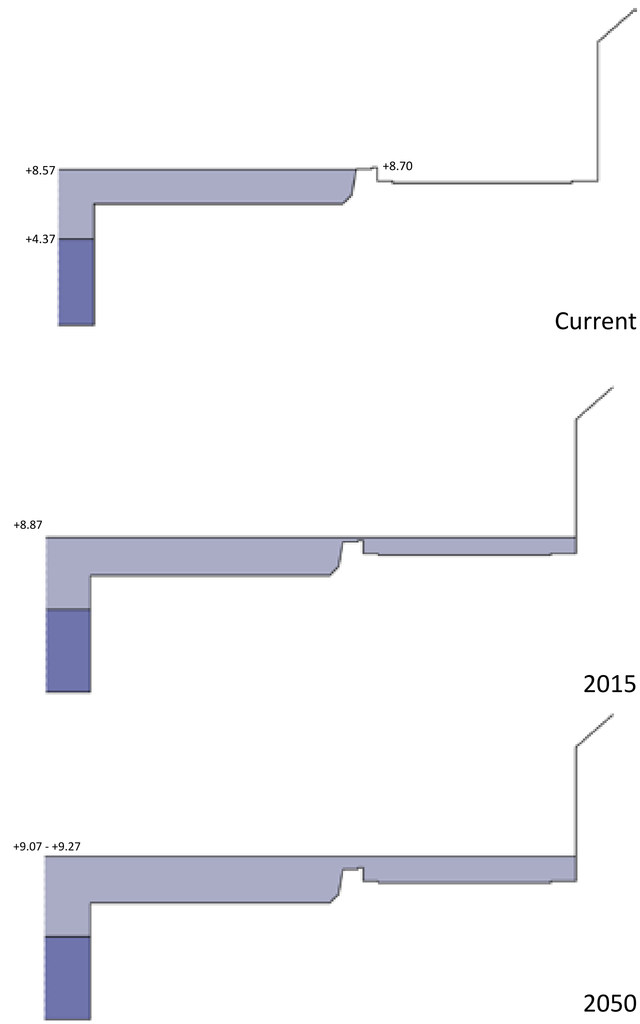


Fig 1.7: Waterlevels of the IJssel in Zutphen.
(Map made by author)

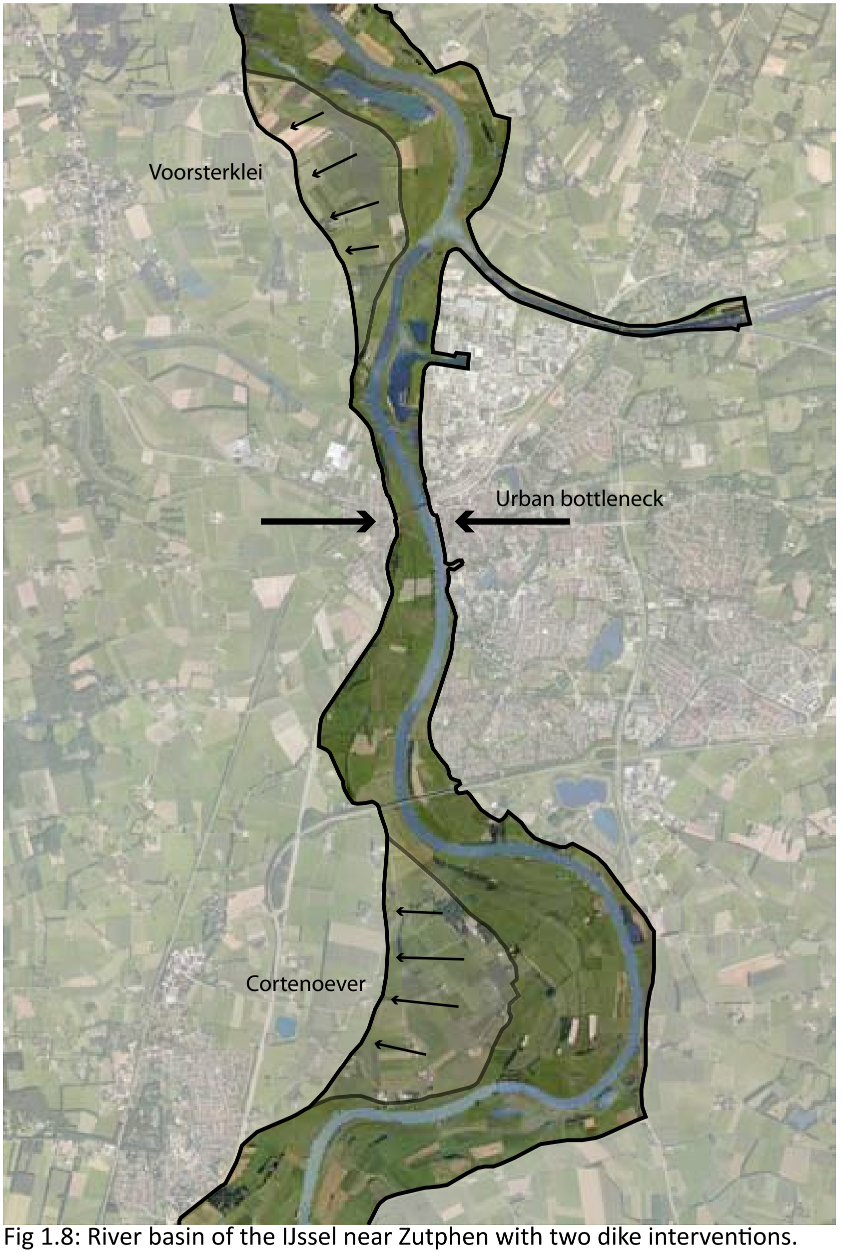


Fig 1.8: River basin of the IJssel near Zutphen with two dike interventions.
(Map made by author)

AIMS AND RESEARCH QUESTIONS

The goal of this graduation project is to find a solution for the water safety problems and to strengthen the spatial qualities in Zutphen. The intervention(s) for the flood protection should not only pay attention to water safety, but should also increase the spatial quality and vice versa. As a result of the water measurements the spatial quality should not be diminished, but strengthened. The main question is: **'How can the difficulties in improving the water safety problems be solved, while the spatial quality is strengthened?'**

The problems in Zutphen are also present in other river cities, so an important aim is to find a generic solution and/or guidelines that can be implemented in other cities as well. In these cities, the same kind of solution should be applied, although with a different local interpretation.

To be able to answer the main question, many related questions have been treated. The most important related questions are listed here.

WATER

Which different possibilities are there to improve the water safety?

What can these interventions add to the spatial quality?

SPATIAL

What are the local spatial problems (and opportunities) in Zutphen?

What is the source of these spatial problems (and opportunities)?

What urban elements contribute to an open relation between the city center and the river?

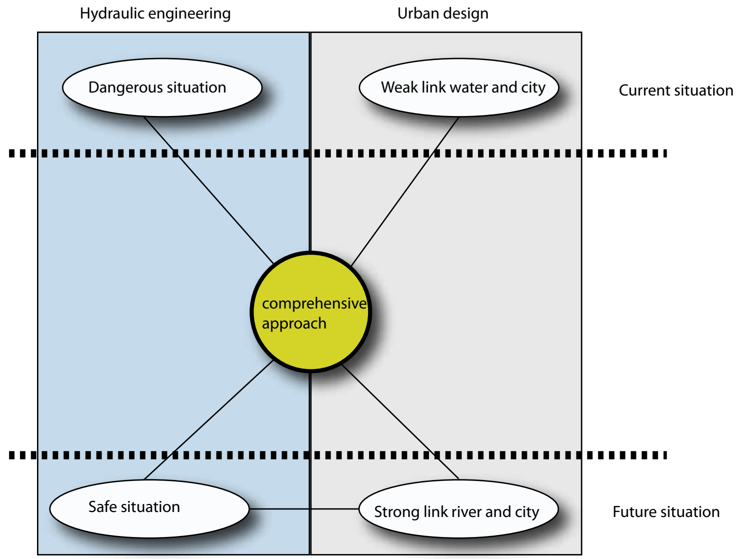


Fig. 1.9: Diagram for a comprehensive approach (Map made by author)

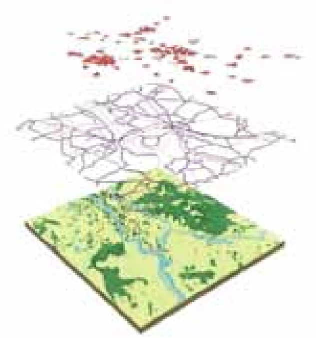


Fig. 1.10: Layer cake model. (source: Meyer et al.,2010)

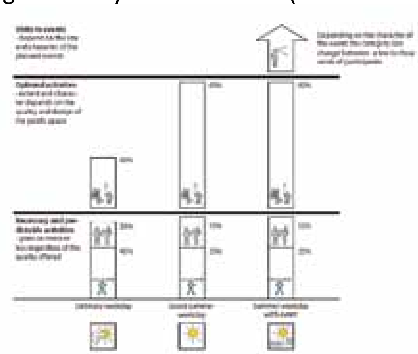


Fig. 1.11: Model for public space users. (source: Gehl,2010)

RELEVANCE

The social relevance section explains how the design project contributes to the social life in this specific case. The part with the scientific relevance shows how the research contributes to the body of knowledge of the academic world.

Social relevance

For all users and inhabitants of the city, it is important to keep the urbanised areas safe from flooding. Without measures being taken, the city of Zutphen will not be safe, the risk is social- and economical damage. This means, improving the water safety is a basic condition for living in the city.

In the current situation, there is some space where people can rest or find recreation on the public quay, but these spaces are surrounded by cars. This is why most of the visitors do not like to stay here, they only pass the riverfront. When visiting the historic city center, it is hard to get to the riverfront. Many people do not know the way, people that do know it have to face several obstacles.

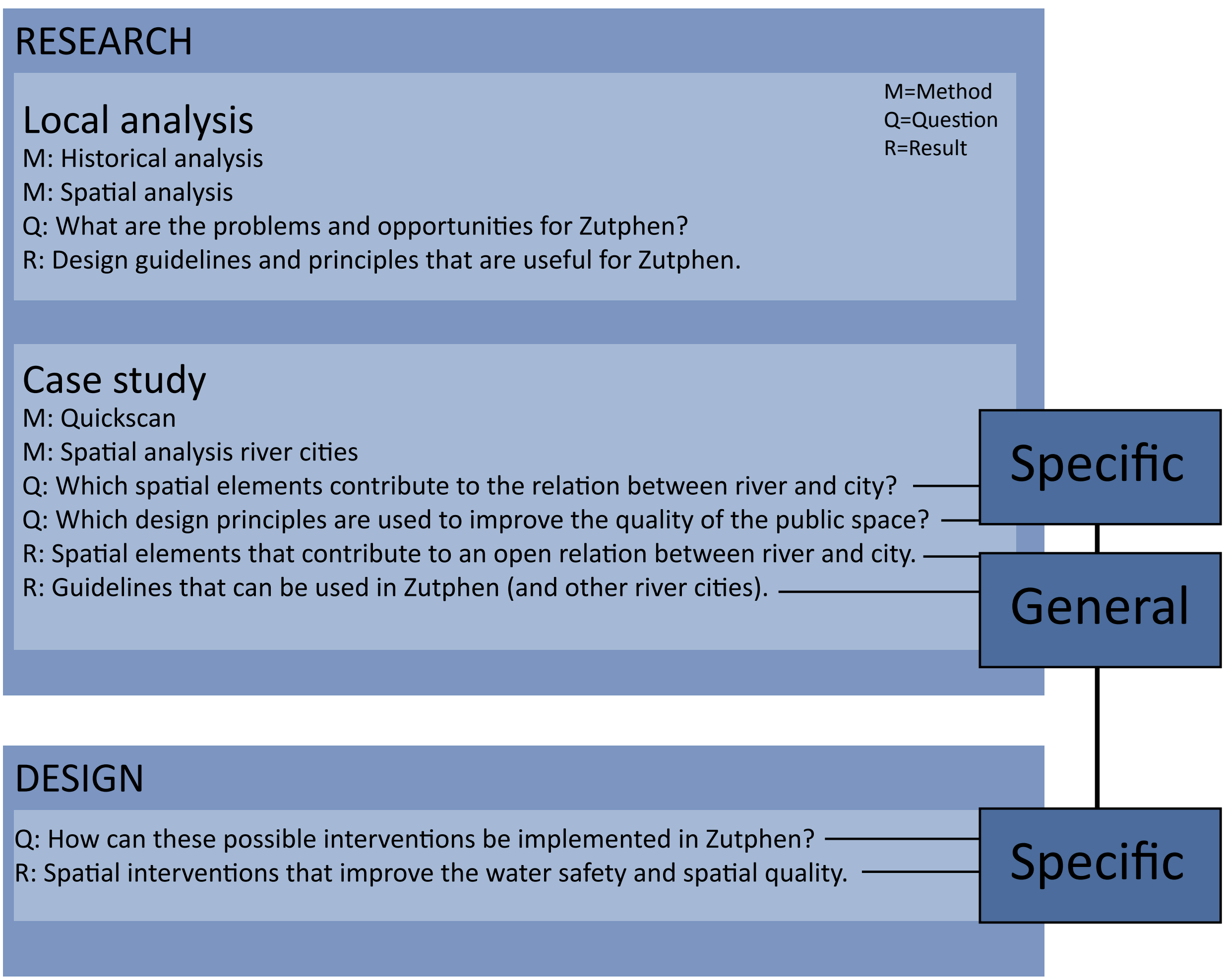
With the new redevelopment of the urban riverfront, the spatial quality will be improved and these problems and complaints will be solved. The target group that should benefit from the intervention is, in the first place, the users of the city center, ranging from recreational visitors (tourists) to everyday-users (inhabitants of the inner-city). The diagram (see fig. 1.10) shows that especially the recreational visitor will benefit from more quality in the public space.

Scientific relevance

In the theory paper (see appendix B), different approaches for solving water safety problems together with improving spatial quality are studied. Many researchers and designers pay attention to the significance of rivers in urban life. In some cases, they only pay attention to the urban problems and neglect the problems in flood defence and water management. This approach of putting spatial development in first place has resulted in floods and dangerous situations. Nevertheless, most approaches realise that water safety is a main condition in making further urban developments possible. This does not mean that measures in flood defence and water management can neglect processes in urban design. The hierarchy model of Meyer et al. (2010), called the 'layer cake model', suggests that interventions on the bottom layer (landscape layer) are most important (see fig.1.11). These interventions affect the second (network layer)- and third layer (occupation layer) and these effects have to be taken into account when there is an intervention in the bottom layer. For the short term (2015), solutions have been found that strengthen the hydraulic situation and maintain the spatial value. But the task for the future is to come to a comprehensive approach that improves the flood defence system, protects the environment and create high-quality urban development and attractive landscapes (Meyer et al., 2010). The 'state of the art' thinking is a development in progress; research is still being done to find this comprehensive approach. This graduation project will contribute to this approach.

METHODOLOGY

The diagram shows the structure of the graduation project. To find out the problems and opportunities for Zutphen, a local analysis is done. The historical analysis is a theoretical study to see the spatial development of the city: this way it is easier to understand the present situation, it also shows the source of current spatial problems. The spatial analysis focuses on the relation between the city center and the riverfront. When the spatial problems are clear, it is possible to start designing and try to find solutions. Since there are many cities with almost the same urban situation as Zutphen, we can learn from studying these cities and find out how they have treated the relation between river and city.
In a quick scan, the different river cities were grouped into four different 'families' of river cities. From each 'family', one city was selected for a case study. This way, the study covered different kinds of river cities. In the case study specific, local urban elements were filtered out and put into general spatial elements and design principles. These general solutions can be implemented in Zutphen and used as a starting point for the design. In the design phase, the generic solutions are applied to the local situation, so they became specific again.


RESEARCH
Local analysis
M=Method
Q=Question
R=Result
M: Historical analysis
M: Spatial analysis
Q: What are the problems and opportunities for Zutphen?
R: Design guidelines and principles that are useful for Zutphen.
Case study
M: Quickscan
M: Spatial analysis river cities
Q: Which spatial elements contribute to the relation between river and city?
Q: Which design principles are used to improve the quality of the public space?
R: Spatial elements that contribute to an open relation between river and city.
R: Guidelines that can be used in Zutphen (and other river cities).
Specific
General
DESIGN
Q: How can these possible interventions be implemented in Zutphen?
R: Spatial interventions that improve the water safety and spatial quality.
Specific

PART II
RESEARCH

This part of the thesis consists of three parts: the historical analysis of Zutphen, the spatial analysis of the relation between the city center and the riverfront and the case study of river cities. In the historical analysis, the focus is on inconsistencies between the landscape-, network- and occupation layer of the city. Conclusions of this analysis are related to the spatial analysis The research criteria that resulted from the spatial analysis are used in the case study, so the different cities can be compared with each other. This makes it possible to obtain general design principles.

HISTORICAL ANALYSIS

To understand the spatial situation of Zutphen, it is necessary to be aware of the development the city has gone through since its origin. In this analysis, the layer-cake model is used. This hierarchy model consists of three layers: the landscape layer, the network layer and the occupation layer. The bottom landscape layer is the most important layer. It contains the soil and the water. Regulation of land and water is a precondition for the Netherlands. This layer should provide solutions for the river discharge and sea level rise. The infrastructural layer is the second layer, which includes all networks forroads, railroads, waterways and spatial nodes. This layer should create conditions for the third layer, the occupation layer. It consists of residential- and business areas, agricultural functions, cultural facilities , etc. (Meyer,2010 and Sijmons, 1998). In the analysis, inconsistencies between the layers are found; most spatial problems are caused by this inconsistencies.

Historical maps used for this research are added in appendix A.

1000 A.D.

The city of Zutphen was established around 900 A.D., at the place where the Berkel flows into the river IJssel. The city was built on an elevated sand hill. In the first place, the settlement was an administrative center, part of the Frankish empire. This center was situated inside the inner wall and the inhabitants lived in the second ring. By land, the city was connected to the north with Deventer, a small port was located on the east side of the city, along the

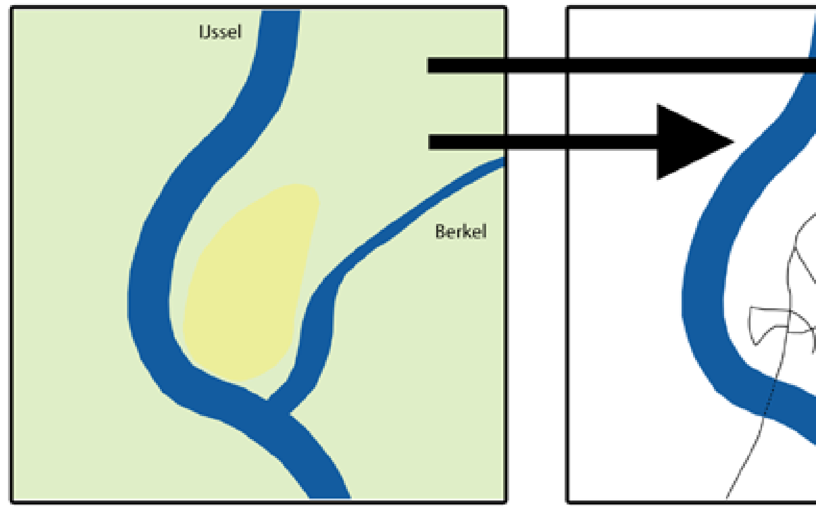


Fig. 2.1: Landscape-, Network and Occupation layer in 1,000 A.D. (Map made by author)

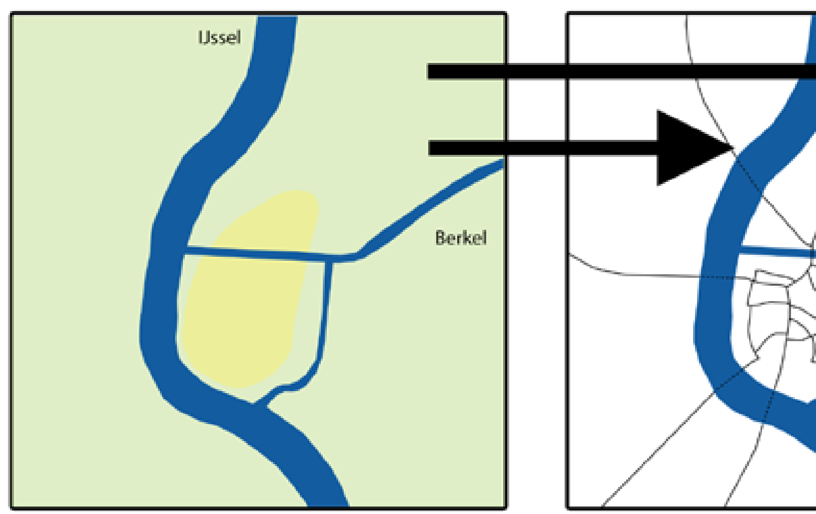
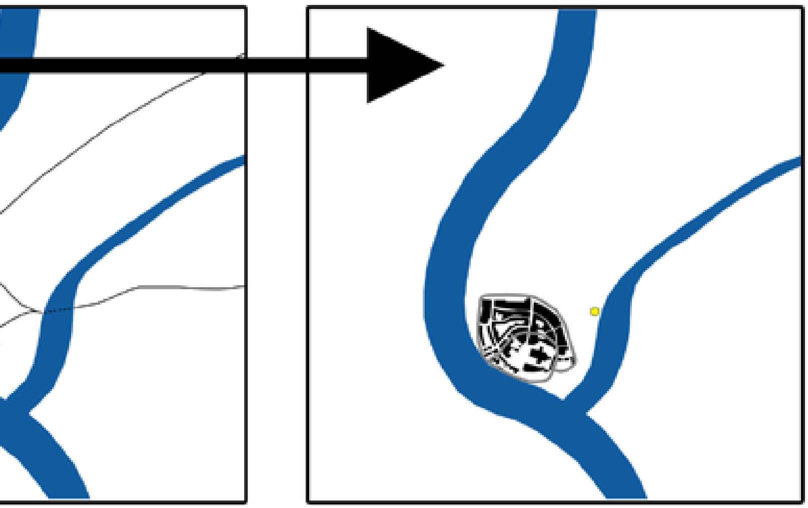


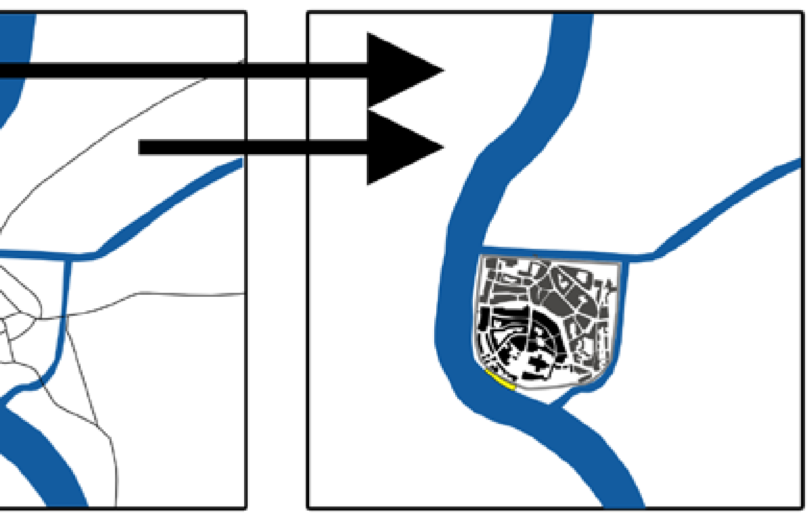
Fig. 2.2: Landscape-, Network and Occupation layer in 1150. (Map made by author)



Berkel. In this period, the network- and occupation layer were related to the landscape layer. (see fig.2.1)

1150

At the end of the twelfth century, the river IJssel got a direct connection with the Rhine (Frijhoff, 1989). Since that time, towns along the IJssel changed into trading cities, dependent upon the river. Zutphen relocated its port to the west, along the IJssel and dug a canal on the north side as a strengthening of the fortification. This meant that the city was totally surrounded by water (see fig. 2.2).



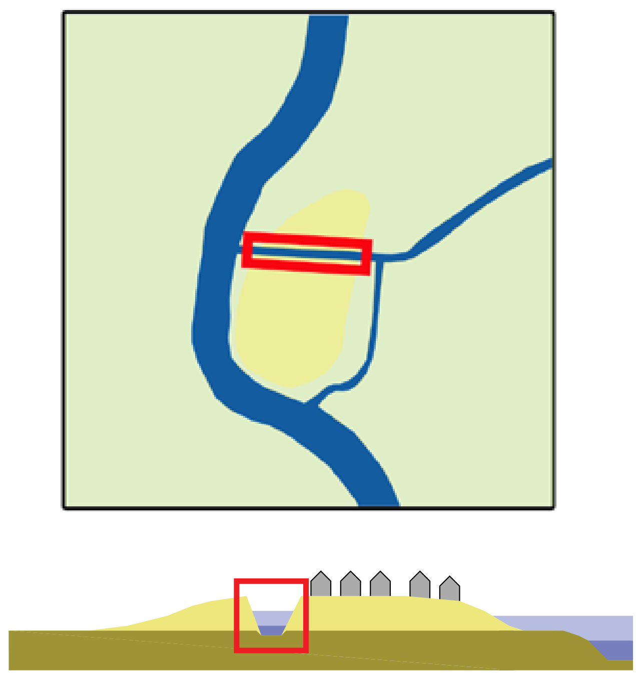


Fig. 2.3: The network layer neglects the landscape layer. (Map made by author)

1250

The new trade attracted many merchants and craftsmen to the city, so a new part of the city was added north of the existing city, on the remaining part of the sand hill. This new area was outside the fortification walls, so in the beginning it was not a part of Zutphen, but an independent city called "*De Nieuwstad*" (The New Town). After Zutphen expanded the walls, "*De Nieuwstad*" became a part of Zutphen; but it is only connected to the center with one bridge (see fig.2.4). In the current situation, the Berkel still flows between the two city parts and "*De Nieuwstad*" is still not really part of the city center.

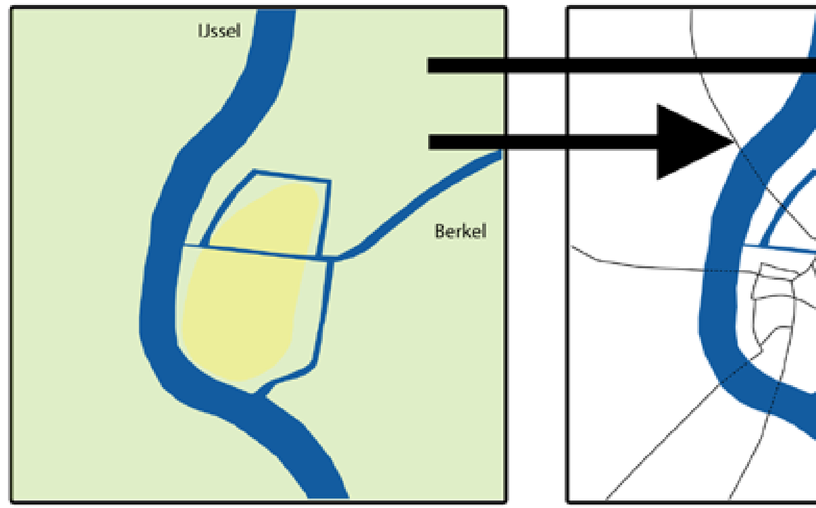


Fig. 2.4: Landscape-, Network and Occupation layer in 1250.
(Map made by author)

1450

Till the end of the fourteenth century, Zutphen knew economic welfare and population growth (Groothedde and Krijnen, 2008). As a member of the Hanseatic league, it was part of an international trading network. New city developments to absorb the population growth were planned east of the city, in the river basin of the Berkel. This area flooded many times, but each time the ground was heightened until it was safe. The consequence of this was less space for the river to flow and to use its natural course.

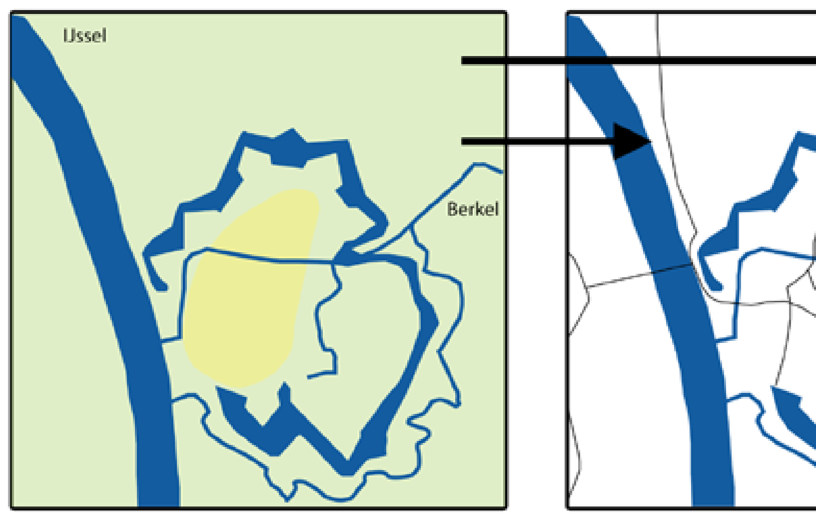
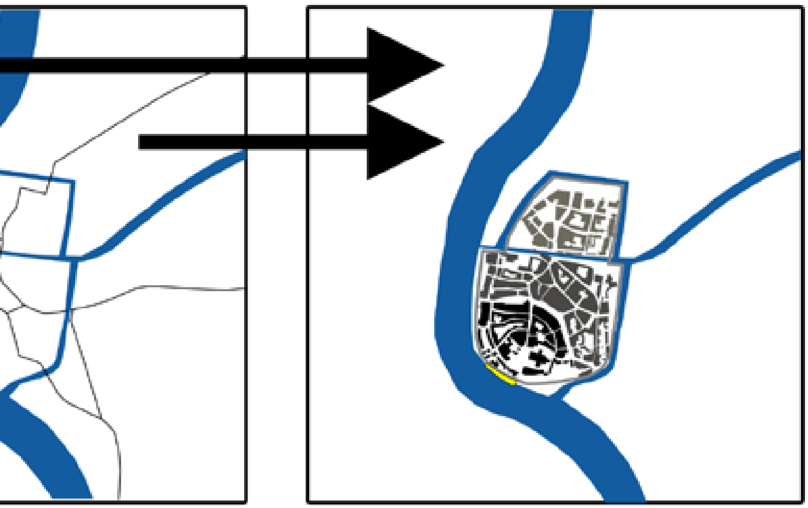


Fig. 2.5: Landscape-, Network and Occupation layer in 1450.
(Map made by author)



In the same period, they changed the course of the IJssel south of Zutphen, because the river came to close to the city walls. Most new vacant space between the city and the river was used for fortification strengthening (see fig. 2.5). In the fifteenth century, the growth of the city stagnated. This was caused by cities in the west of the Netherlands, which took over most of the trading activities of the eastern- and northern cities (Rutte and van Engen, 2005).

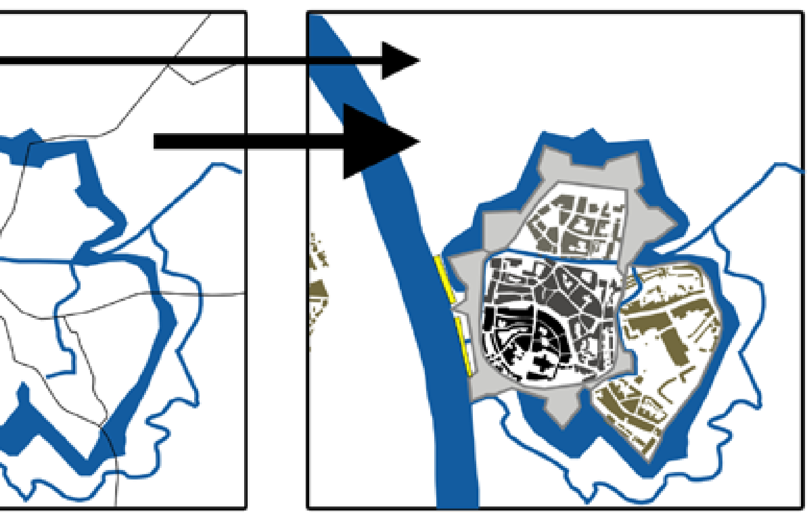


Fig. 2.6: The occupation layer neglects the landscape layer. (Map made by author)

1880

Not much city developments took place till the end of the nineteenth century. At this time, some changes took place that had a huge influence on the current spatial situation. The 'Fortification Act' made it possible to tear down all the walls around the city. On the riverside, the new vacant space was immediately occupied by merchants, who built their houses next to the river and in the river basin. So new flood defence walls were needed to keep the water out. For the river itself this meant the beginning of the urban bottleneck near Zutphen. In the same period, the new train bridge north of Zutphen was built, which completed the bottleneck. This bridge was needed to complete the train route from Arnhem via Zutphen to Deventer. The rail road took up the space that was left from the walls on the north, so after the fortification walls Zutphen had a new barrier on the north side of the city (see fig.2.7).

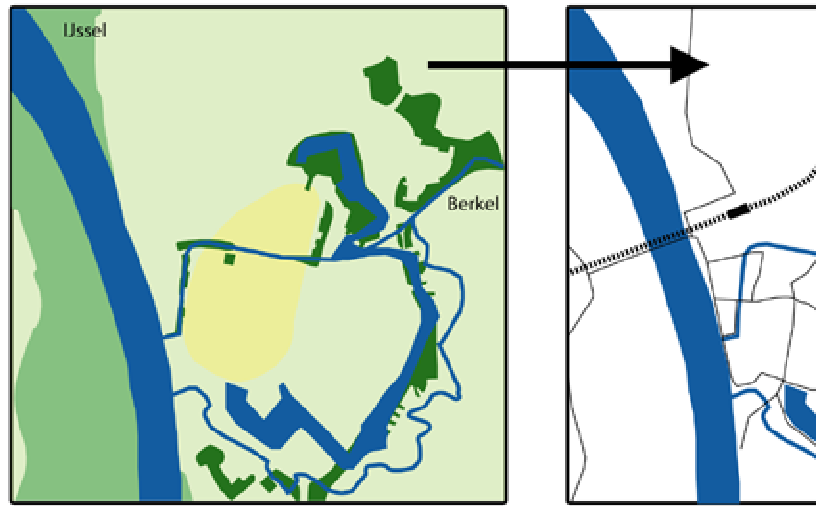


Fig. 2.7: Landscape-, Network and Occupation layer in 1880.
(Map made by author)

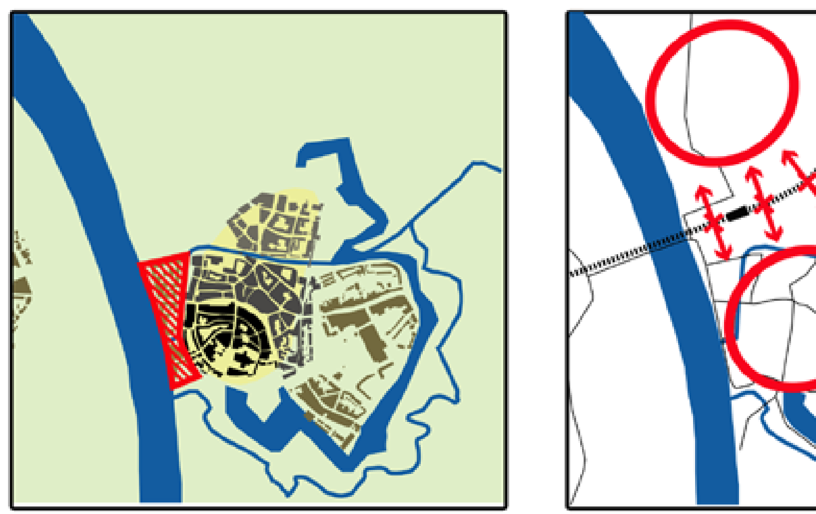
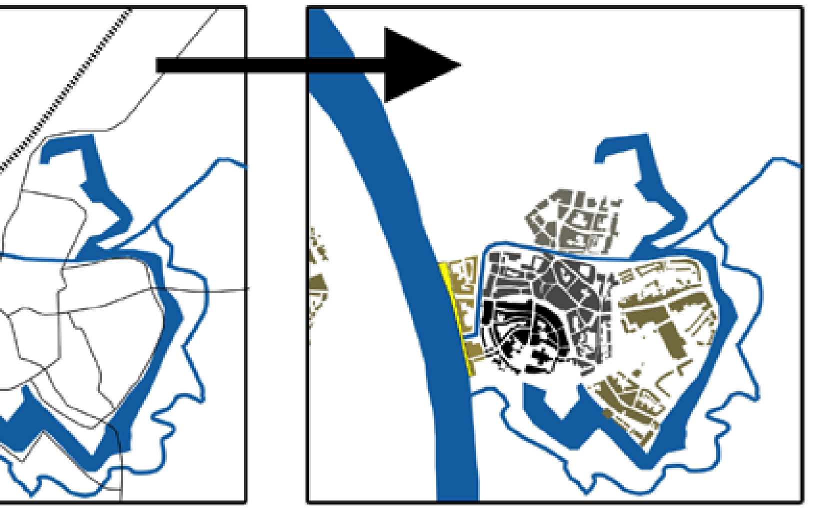
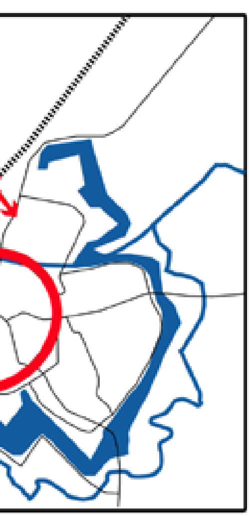
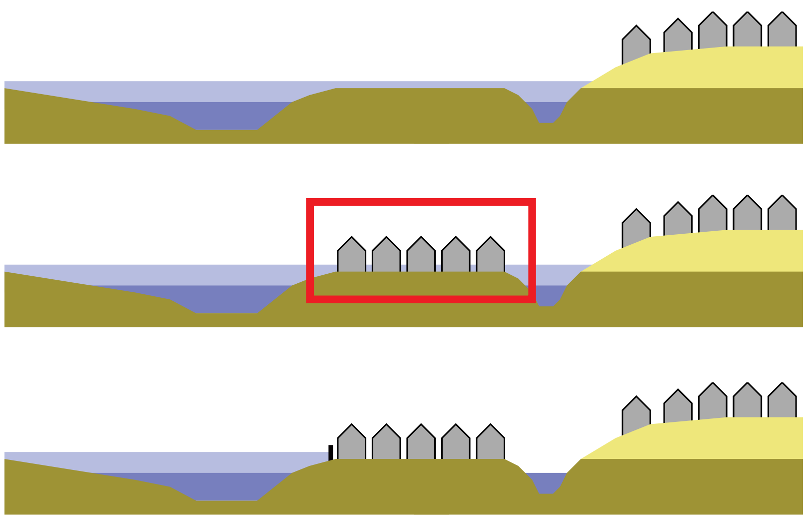


Fig. 2.8: The occupation- and network layer neglect the landscape layer.
(Map made by author)







Twentieth century
In the twentieth century, the city developed to the south and east, due to the northern barrier and the river on the west. Most harbor activities were relocated, away from the center, north of the rail road. This northern area ("De Mars") developed into an industrial- and business area after World War II. So you can see that the rail barrier had a huge influence on the development of the city in the twentieth century. The occupation layer is no longer related with the landscape layer and furthermore, it became dependent of the network layer (See fig.2.10).

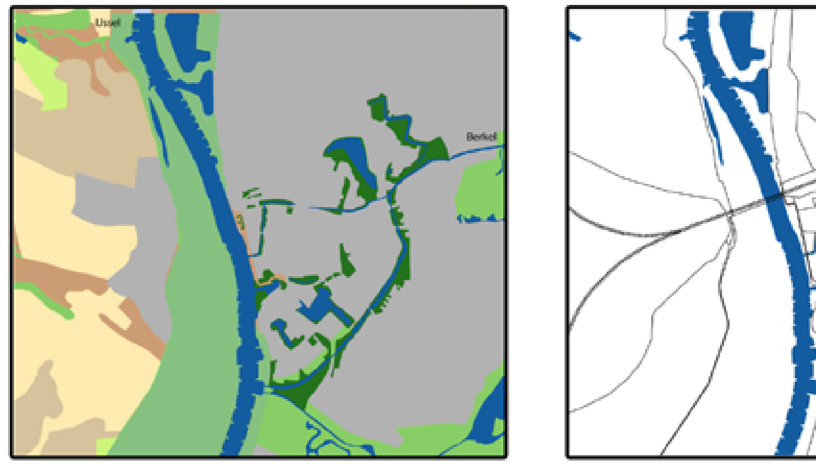


Fig. 2.9: Landscape-, Network and Occupation layer in 2000.
(Map made by author)

Conclusions
The problem map (fig.2.11) shows the different locations in the city where inconsistencies between the layers occur. The developments at the end of the nineteenth century exert a huge influence on the relation between the city and the river. The expansion towards the river and the construction of the bridge in the river basin caused a bottleneck in the river and are an important factor in the current water problems. The expansion also caused a distance between the city center and the river. There is no direct relation between the public riverfront and the medieval city center. The barrier caused by the rail road and the bridge makes it difficult to expand city life to the north side of the city.

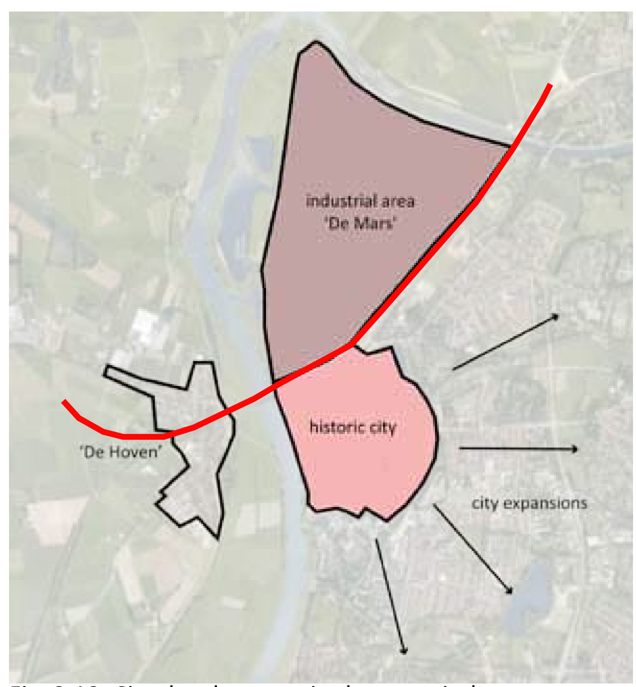
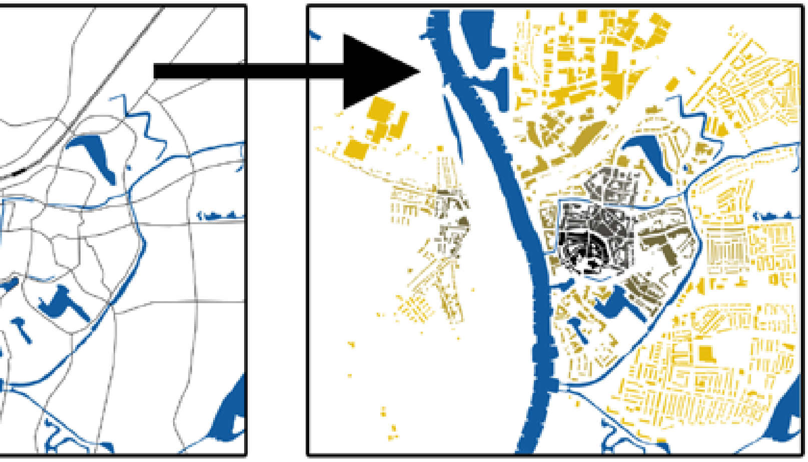


Fig. 2.10: City development in the twentieth century.
(Map made by author)



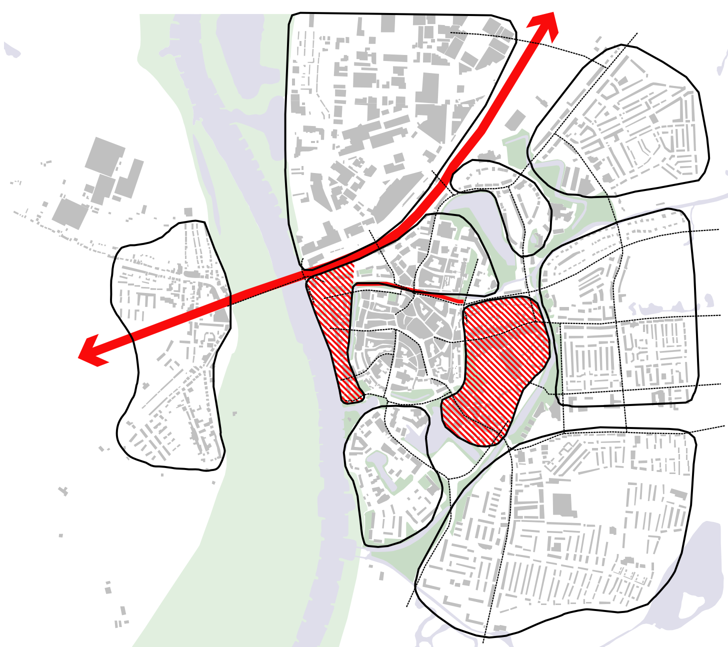


Fig. 2.11: Map with problem locations.
(Map made by author)

SPATIAL ANALYSIS

In this analysis, the focus is on the spatial relation between the city center and the riverfront. The aim is to find the problems and opportunities in this relation for Zutphen and to define criteria which are sufficient to evaluate a river city. These criteria are necessary to compare different river cities in the case study.

Pedestrian zone unrelated with river

The map in figure 2.12 shows that the pedestrian zone of the city is not connected with the river. The pedestrian network connects the important public buildings in the city, along the riverfront these buildings are not present. There are some possibilities to create a pedestrian access to the riverfront, but there are some traffic barriers between the center and the river. Especially the road along the quay is a major thoroughfare in the local infrastructure. The historical analysis showed that the area between the center and the river was built later. This had ensured that the building types are different and thus people immediately know that they are leaving the city center.

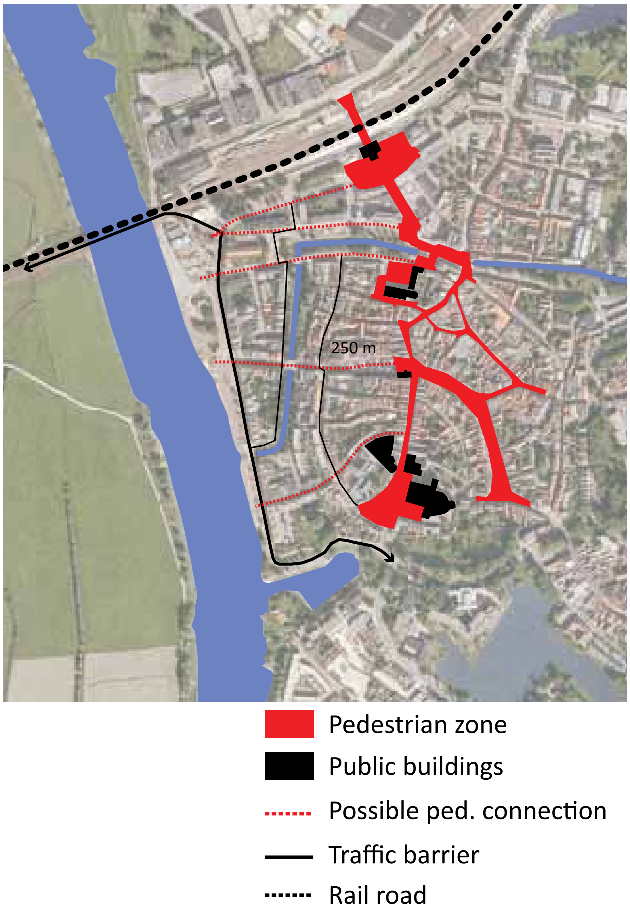


Fig. 2.12: Pedestrian zone. (Map made by author)

Fig. 2.14: View points (Maps made by author)

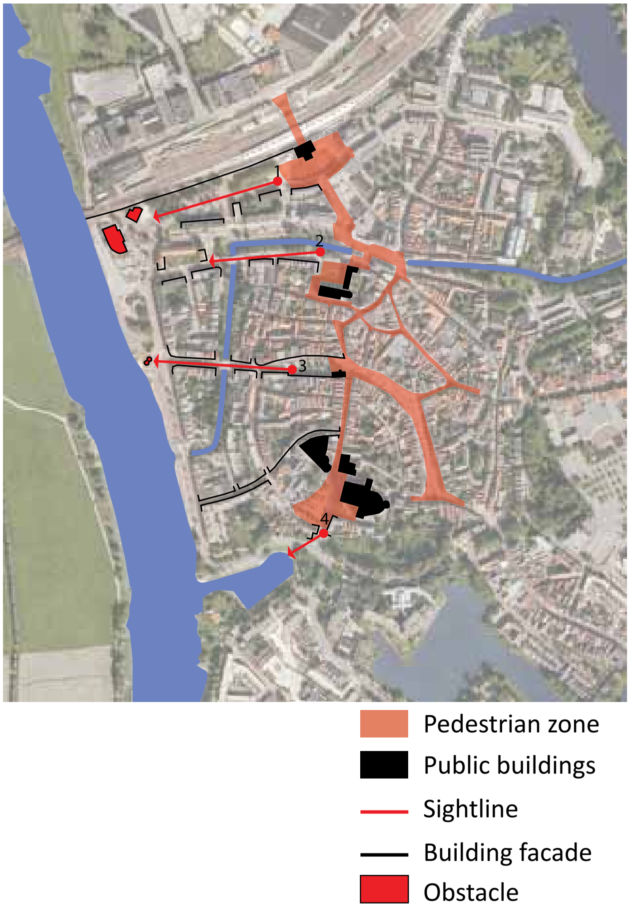
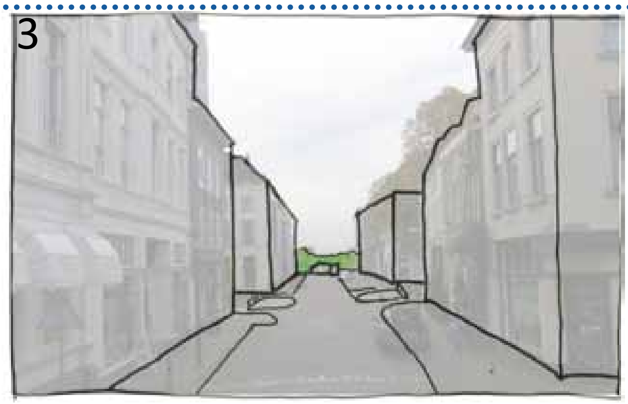
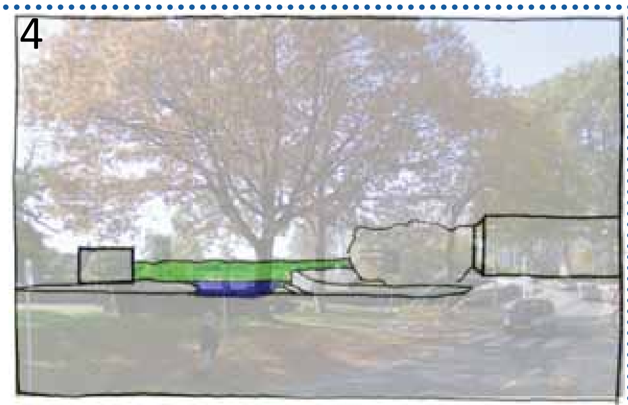


Fig. 2.13: River views. (Map made by author)

River view

It is important to be aware of the river when you are in the city center, so it would an advantage if you could see the river from different points in the center. Figure 2.13 shows important places in the city and their view of the river, from two places it is currently possible to see the river. From point two you can see the Berkel, a secondary river and if you follow this smaller river you will end up on the quay. The street pattern in Zutphen is oriented in relation to the river. This can be explained from a historical point of view, as the city has long been dependent on trade on the river. But at some places, the view is blocked by buildings, such as a pavilion and a kiosk on the quay, especially since these buildings also want to be in sight.





Few activities on the quay

Most space on the quay is occupied by parking (see fig. 2.15). There is also a public recreational area combined with green and fountains. In the middle of the quay is a small kiosk and near the bridge is a restaurant. The riverfront buildings accommodate view public functions; there are some restaurants and clubs. Most buildings are used for living and for services such as law firms. The houses from the 1960s and 1970s only contain housing. There is no clear zoning on the quay; the different building periods and functions are not related with each other and the quay.

IJsselpavilion

Staying area

Parking

Fig. 2.15: Functions on the quay.
(Map and photos made by author)

1960s and 1970s buildings

Nineteenth century buildings

Green area

Weak connection to the north

On the south side, the riverfront ends with a small yacht harbor with a green surrounding. On the north side, there is the pavilion and a narrow passage to 'De Mars'. The passage is outside the dikes, so during several times a year the passage is flooded and can't be used. The former industrial area on the north will change into a living area with city center functions in the near future and therefore it will be part of the inner city. This means that the connection with the new area should improve.


Fig. 2.16: Connection to the north. (Map made by author)


Fig. 2.17: Developments in 'De Mars'.
(source: www.kcap.eu)


Fig. 2.18: Passageway flooded. (Photo made by author)

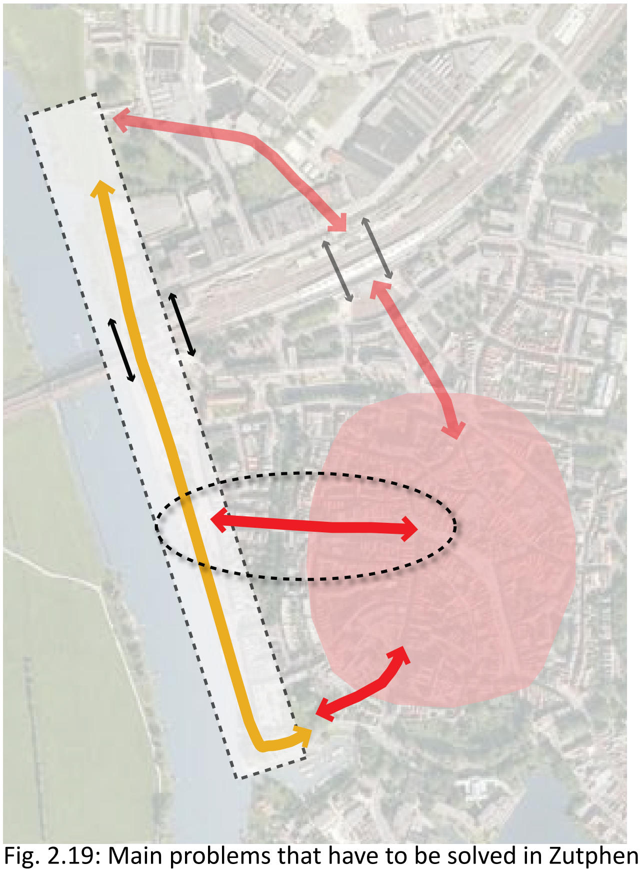


Fig. 2.19: Main problems that have to be solved in Zutphen: link between the city-center and the river and the connection to the north. (Map made by author)

Criteria

In Zutphen, there are problems with the link between the city center and the riverfront and the connection to the north. This has to do with different urban aspects. From this spatial analysis and literature (Gehl, 2010) I draw upon four criteria to evaluate the situation in different cities.

Pedestrian access

Can pedestrians reach the river from the city center in a pleasant way?

Visual link

Can people see or experience the riverbasin from the city center?

Activities near the river

Which functions are located along the river?
Are the functions on the quay related to each other?
How is the zoning?

Connections along riverfront

Is the riverfront connected with surrounding areas along the river?

CASE STUDY

This chapter consists of two parts: the quick scan and the actual case study. Several river cities were randomly chosen and the quick scan acts as a selection procedure. The selected river cities are studied on the basis of the four criteria used in the case study.

Quick scan

Seventeen river cities (including Zutphen) were chosen for the quick scan. In the quick scan, the focus is on the urban structure of the cities. How are the city center, public quay and river located compared to each other? The example (fig. 2.20) shows the case of Zutphen: the inner city is not directly connected with the riverfront and the river. There is an in-between urban area. In figure 2.21 you can see that the city center, public quay and river are directly linked in Deventer. At the end, four different river city 'families' were found (see fig. 2.22). From each 'family' one city was selected for the case study and therefore the results of the case study are as diverse as possible.

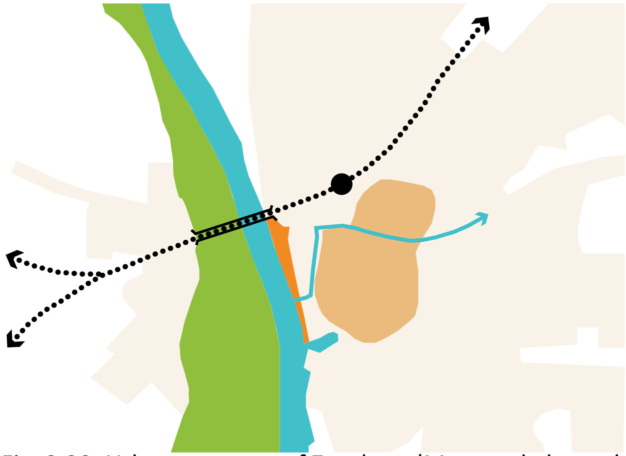


Fig. 2.20: Urban structure of Zutphen. (Map made by author)

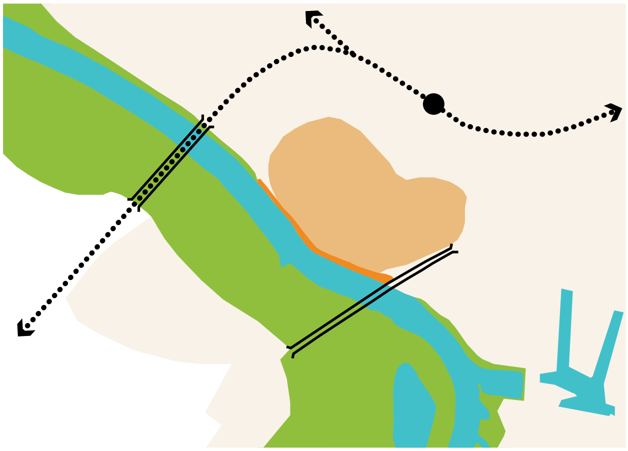
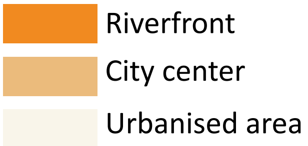


Fig. 2.21: Urban structure of Deventer. (Map made by author)



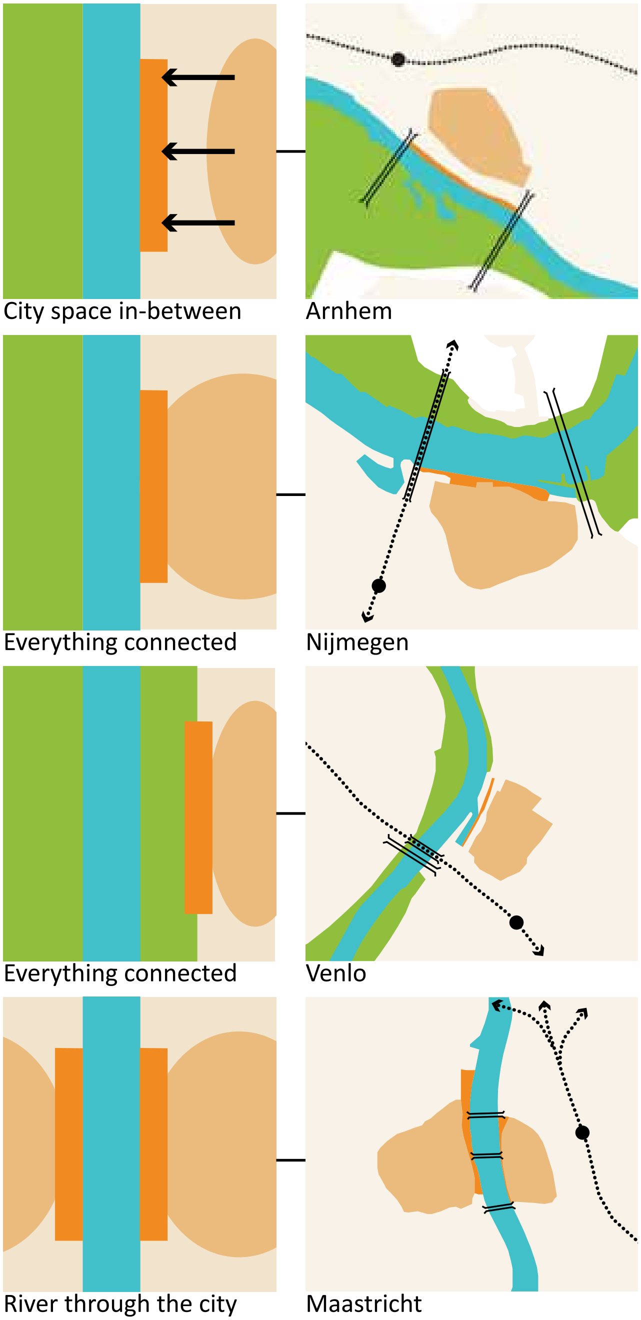


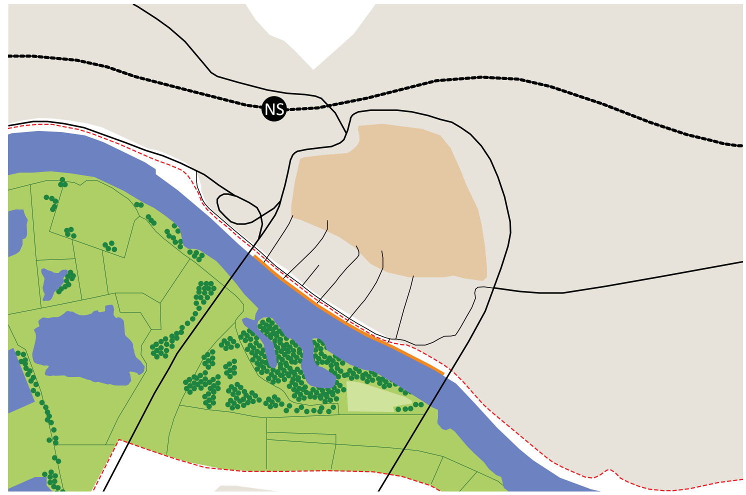
Fig. 2.22: Different typologies and selected cities.
(Maps made by author)

Selected cities

In each 'family' are included one or more cities which are planning interventions for the short term or which have just finished a riverfront project. These cities are the most interesting examples for the case study, since you can see here which urban elements influence the relation between city and river. In the 'City space in-between' group, Arnhem is planning the 'Rijnboog' project. The goal of this intervention is to expand the inner-city to the riverfront. Nijmegen is selected because of the 'Waalsprong' project, a project where water safety and spatial quality are both important. Venlo is at this moment working on a new 'Maasboulevard', whose aim is to attract more people to the riverfront. In Maastricht, in which the 'Ceramique' project is already finished, a new walking route along the river was successfully created. In appendix C all treated cities are shown.

Case study
In the case study, the four criteria are used to analyse the different cities. Results from the case study are spatial elements that are important for these criteria and design principles that you can use to affect these spatial elements. These general design principles can be used in the design of Zutphen and in other river cities. Here, Arnhem is used as an example to explain how the spatial elements and design principles are generated and the whole case study is added in appendix D. After explaining the case study of Arnhem the results of the total case study are shown.

Arnhem
In the first place, the current situation of Arnhem is analysed and the different criteria are rated. In the second phase, the hypothetical situation after the 'Rijnboog' intervention is analysed and rated. This way, the different situations can be compared. For the design phase, it is also useful to rate the criteria; this way you can see the strong and weak points of the case study cities, it is easier to implement only the strong elements.
In the overview in figure 2.23, you can see that Arnhem has the same problems with the pedestrian access as Zutphen; i.e.,no pedestrian zone, infrastructural barriers and different building types towards the river.



Inhabitants| 147,000
River| Nederrijn

Pedestrian access
- No pedestrian zone to the river.
- Infrastructural barriers between center and river.
- Different building typologies in center and in between area.
- Distance from city center to the river is 240 metres.

Visual link
- Small difference in altitude between city center and riverfront.
- Obstacles block the view.

Activities near the river
- Restaurants and bars.
- Parking.
- Recreation (nature area).
- Space for events.
- Building functions related to the quay.

Connections along riverfront
- Industrial area and residential area.

Fig. 2.23: Case study results of Arnhem. (Maps made by author)

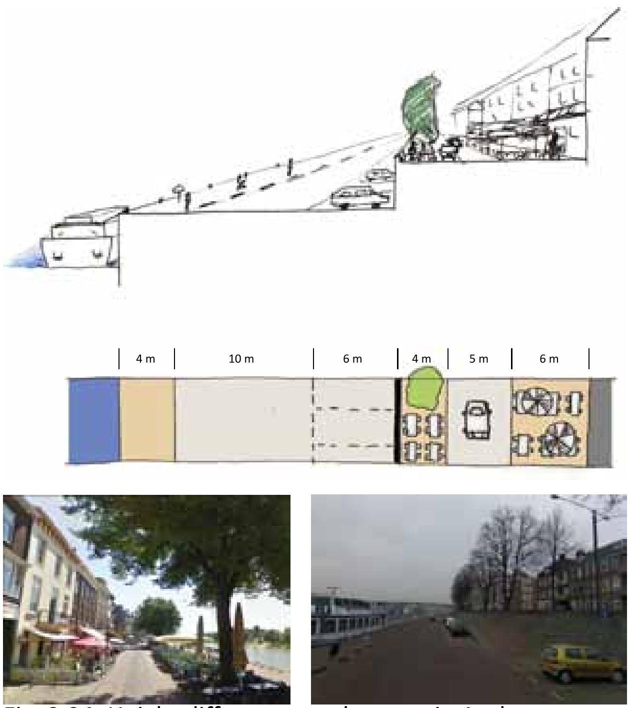


Fig. 2.24: Height difference on the quay in Arnhem.
(Source: Google Earth)

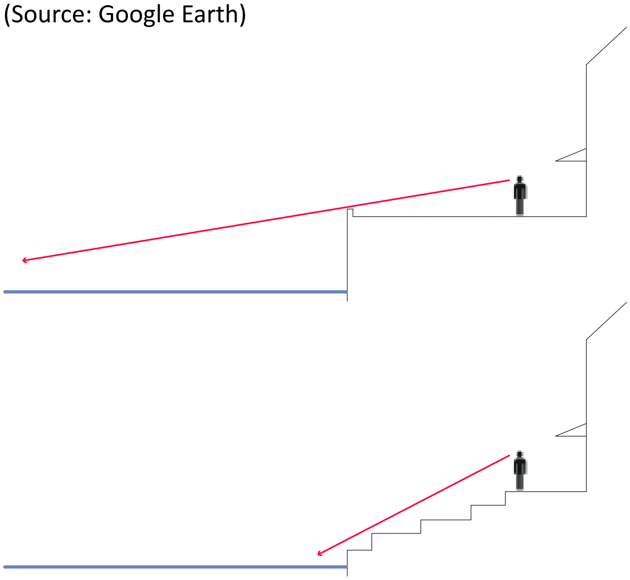
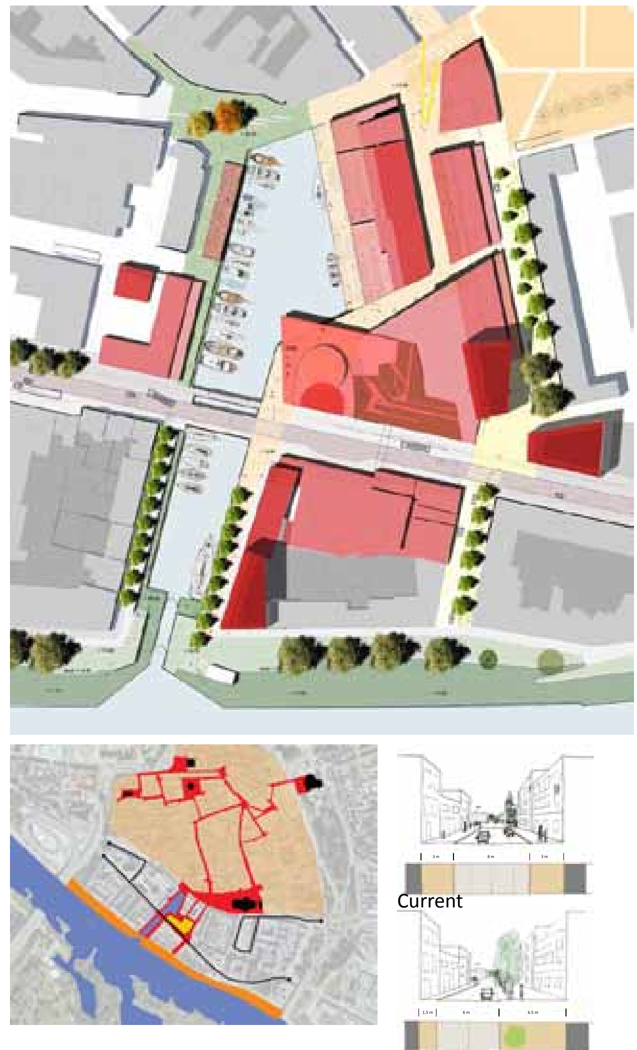


Fig. 2.25: Effect of height difference on the quay.
(Maps made by author)

It is interesting to note the height differences on the quay, this way the visual link with the water is better. It also allows different functions on the quay to be separated from each other - in this case, parking and terraces. So for the visual link, an altitude difference is a spatial element and different heights on the quay is classified as a design principle. In Arnhem there are also many functions along the river and this attracts people to the river-front.

The hypothetical situation is also analysed after the ‘Rijnboog’ project. In dark blue, you can see how the rating has changed (see fig. 2.26). The pedestrian access is improved due to expansion of the pedestrian zone and less traffic barriers. In the new area, the public space is reorganised in favor of pedestrians and the traffic network is changed on the larger scale, the thoroughfare goes around the city center. Spatial elements that play a role here are the pedestrian zone and the infrastructural barriers. The applied design principles are reorganisation of the public space and restructuring of the infrastructural network on a larger scale.



Pedestrian access
- Pedestrian zone to the riverfront.
- Less infrastructural barriers.

Visual link
- River view from city center.

Activities near the river
- Cultural center near the riverfront.

Fig. 2.26: Hypothetical situation after ‘Rijnboog’ project. (Maps made by author)

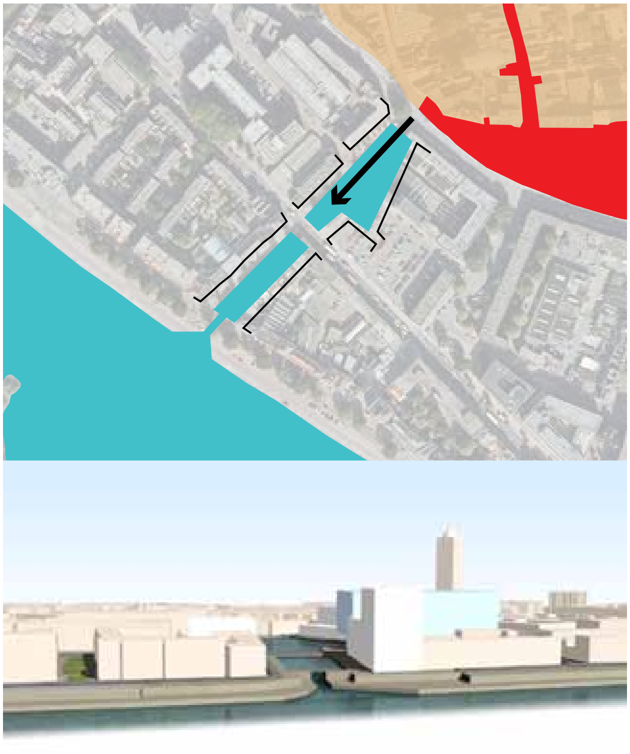


Fig. 2.27: The harbor into the city
(Source: www.rijnboog.nl)

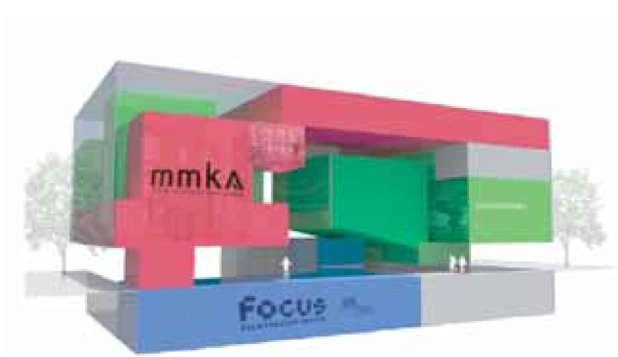


Fig. 2.28: New cultural center as destination.
(Source: www.rijnboog.nl)

The visual link has also improved. This is because the water is pulled into the city in the form of a marina. Although this plan will not be realised, it can be seen as an important design principle for the visual link. In Arnhem, they also add a new function near the riverfront - in this case, a cultural center. This will be the only cultural center in the city center, so people have to go to the riverfront to visit it. It makes it more likely that the new pedestrian zone will be used. The spatial element here is adding destinations and the design principle is to locate it in a position where it is of influence on the pedestrian stream.

On the next page, the overview of all the spatial elements and design principles is shown.
In the design part, it is explained which design principles are implemented in Zutphen.

OVERVIEW RESULTS

Pedestrian access

Spatial elements

Pedestrian zone
Infrastructural barriers
Different building tyopologies
Distance between city center and riverfront

Visual link

Spatial elements

Street pattern
Altitude difference between city center and riverfront
Obstacles

Activities near the river

Spatial elements

Destinations
Riverbased functions
Different building types along the quay
Zones with different functions

Connections along riverfront

Spatial elements

Kinds of surrounding areas
The way surrounding areas are connected

Design principles
Reorganize public space
Restructure infrastructure
Create a walking route
Redesign public quay

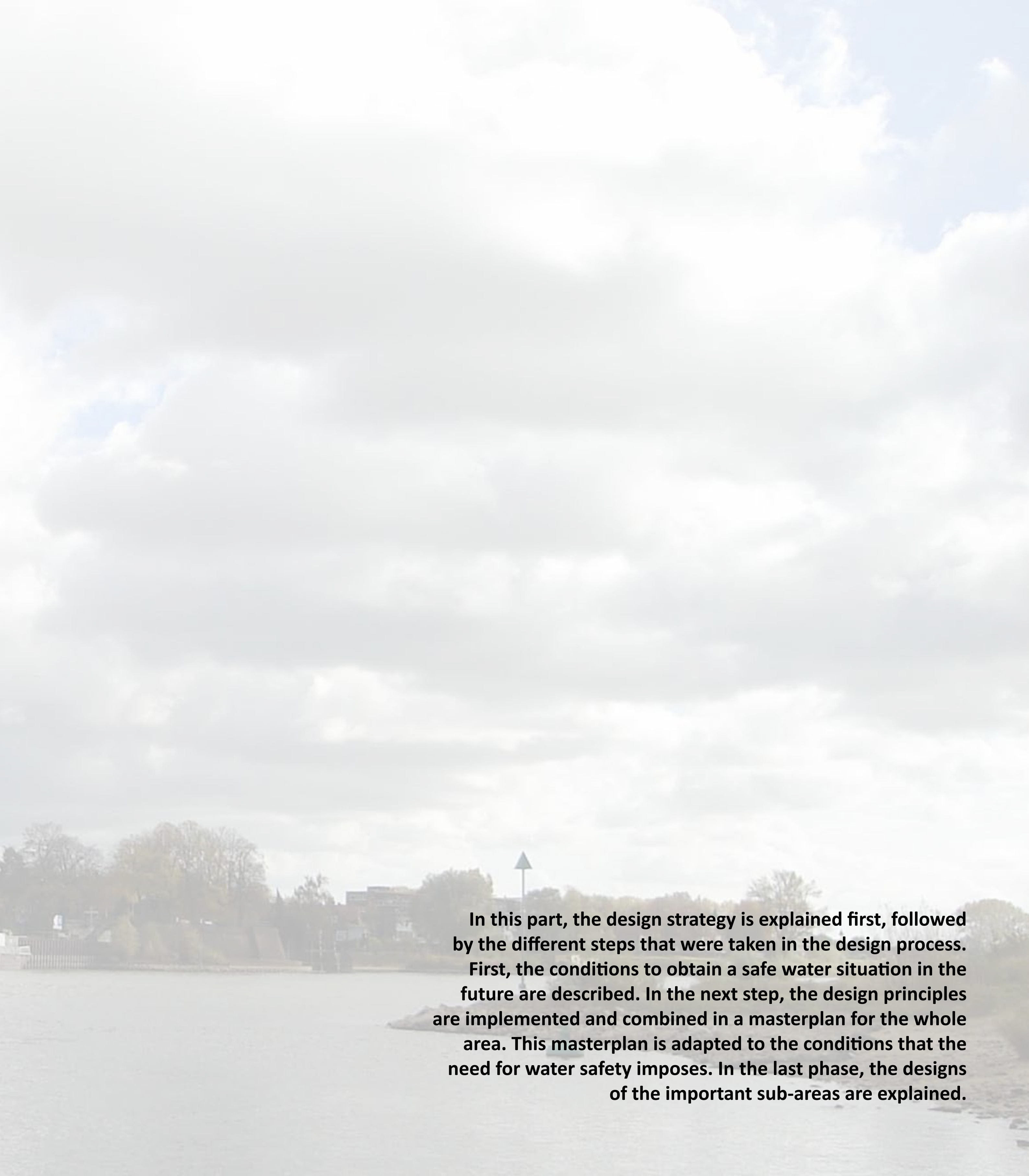
Design principles
Orient street pattern on river
Different height levels quay
Water into the city
Removing obstacles

Design principles
Add function as destination to attract people and change pedestrian flow
Create space for terraces and/or events
Create possibility for riverbased recreation
Relate functions to the different building types
Create different functional zones

Design principles
Create network through the river's nature area
Extend public riverfront
Create connections between opposite sides of the river

PART III

DESIGN



In this part, the design strategy is explained first, followed by the different steps that were taken in the design process. First, the conditions to obtain a safe water situation in the future are described. In the next step, the design principles are implemented and combined in a masterplan for the whole area. This masterplan is adapted to the conditions that the need for water safety imposes. In the last phase, the designs of the important sub-areas are explained.

DESIGN STRATEGY

The design is based on the hierarchy model that is also used in the historical analysis (layer-cake model).

The hierarchy model consists of three layers: the landscape layer, the network layer and the occupation layer. The bottom landscape layer is the most important layer: it contains the soil and the water. Regulation of land and water is a precondition for the Netherlands. This layer should provide solutions for the river discharge and sea level rise. The infrastructural layer is the second layer, which includes all networks for roads, railroads, waterways and spatial nodes. This layer should create conditions for the third layer, the occupation layer. It consists of residential- and business areas, agricultural functions, cultural facilities etcetera (Meyer et al.,2010 and Sijmons, 1998).

So the first thing to take care of is the water situation, as the solution for this problem is a precondition for the network- and occupation layer. But it is important to keep in mind the possibilities for strengthening the spatial quality when solving the water problems.

The next step in the design is to adjust the infrastructural situation to the new conditions. For this intervention the same applies: take into account the current spatial problems and the possibilities for creating solutions for the future. In this phase it is already possible to use the design principles from the case study.

These design principles are also implemented in the spatial design, where it will be considered if they add something to the spatial situation and how they can be combined. The result of this phase is a masterplan for the urban river area of Zutphen. In the last phase, important sub-areas are designed in detail.

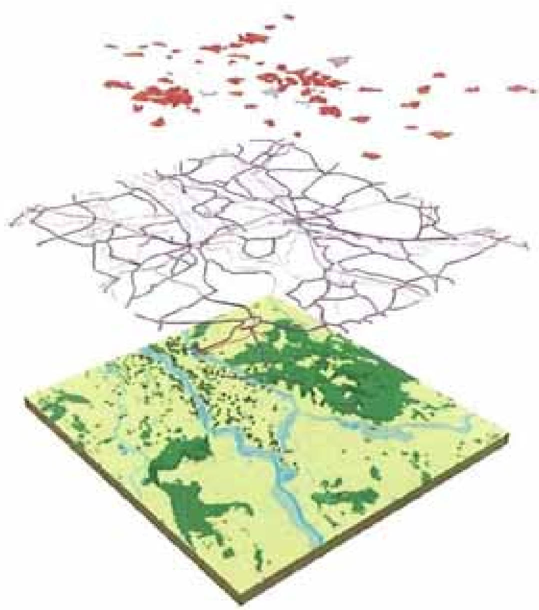


Fig. 3.1 Layer cake model. (source: Meyer et al.,2010)

WATER SITUATION

For the long term (2050), a water level rise of 20 to 40 cm in the IJssel near Zutphen is expected during high water. Because it is not sure how much the water level will rise exactly, there is a change of an unnecessary large investment if you try to solve the problem for the worst case scenario at once. Therefore I propose to decrease the water level with 20 to 30 cm at first. After a certain period (about twenty years) should be determined whether new interventions are necessary. The current design should take new future interventions into account. This way it is possible to deal flexibly with the uncertain predictions of water level rise.
Different generic 'Room for the river' interventions will be used for the first intervention: removing obstacles (bridgehead and IJsselpavilion), shift back the dike and lowering the quay. These measurements will reduce the bottleneck in the river and also provide solutions for the spatial task. For example: removing the bridgehead and shifting back the dike strengthen the relation between the 'Noorderhaven' and the current public quay. Raising the dike doesn't help reducing the bottleneck in the river and it creates a physical- and visual boundary between the water and the city. So this solution will not be used.
Calculations (see p.51) show that the water level will decrease with 32 cm near the bridge when there is a riverflow of 16,000 m^3/s near Lobith. This reduction will be a little less when the riverflow increases to 18,000 m^3/s. Near the 'Marspoortstraat' the water level will be lowered with 21 cm during high water. This intervention will lead to a lower water level of 5 cm near Arnhem.

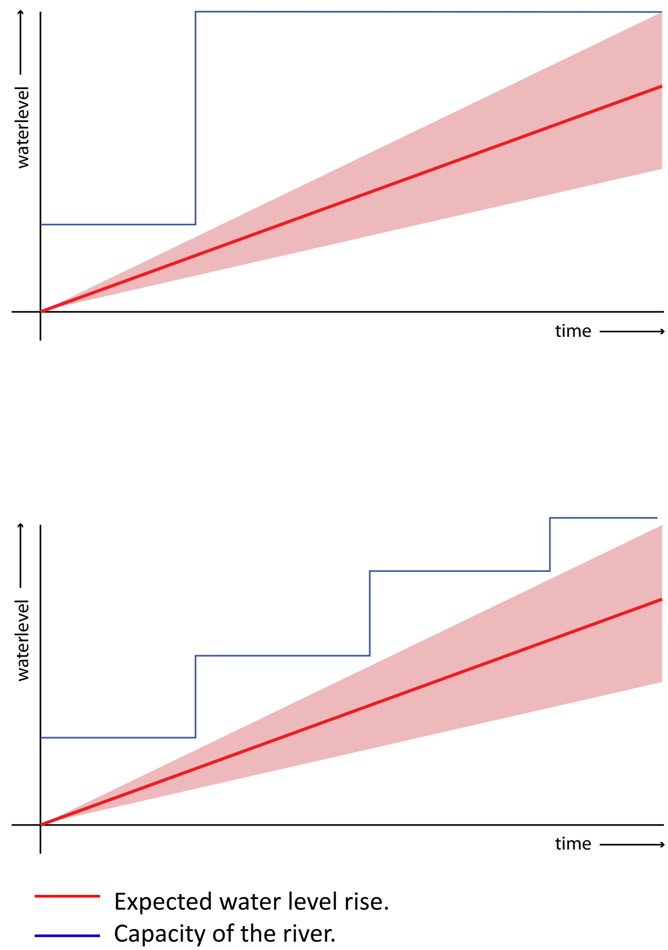


Fig. 3.2: Different smaller steps instead of one big step. (Diagrams made by author)

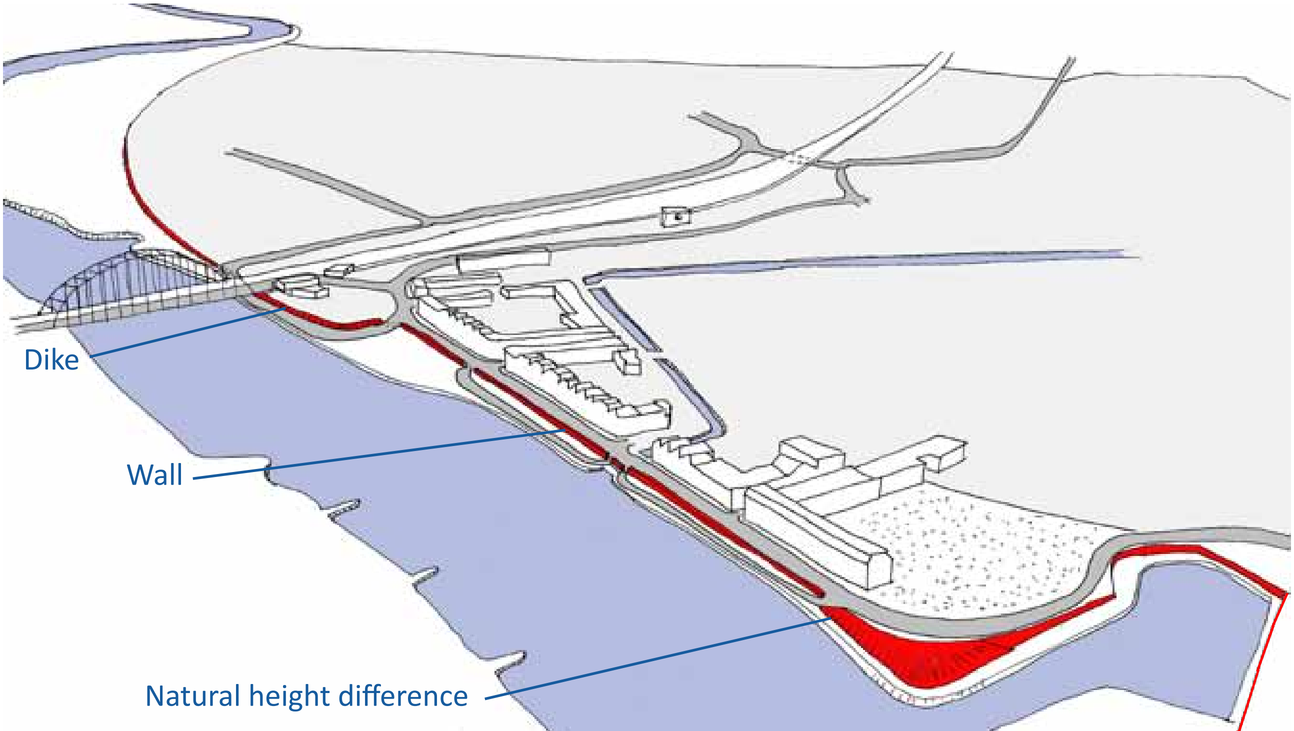


Fig. 3.3: Current water defence system. (Map made by author)

Take out bridgehead.
Effect: -4 cm

Shift dikes back.
Effect: depends

Secondary channel.
Effect: -12 cm

Lowering flood plain or quay.
Effect: depends

Lowerin cribbs in the river
Effect: -2 cm

Raising the dike.
Effect: depends

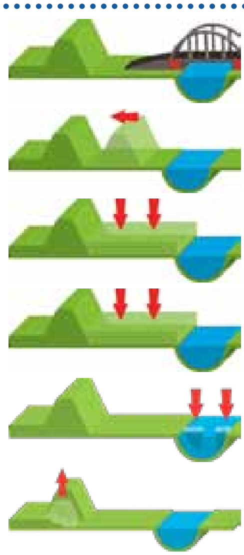


Fig. 3.4: Proposals for water solutions.
(Source: www.ruimtevoorderivier.nl)

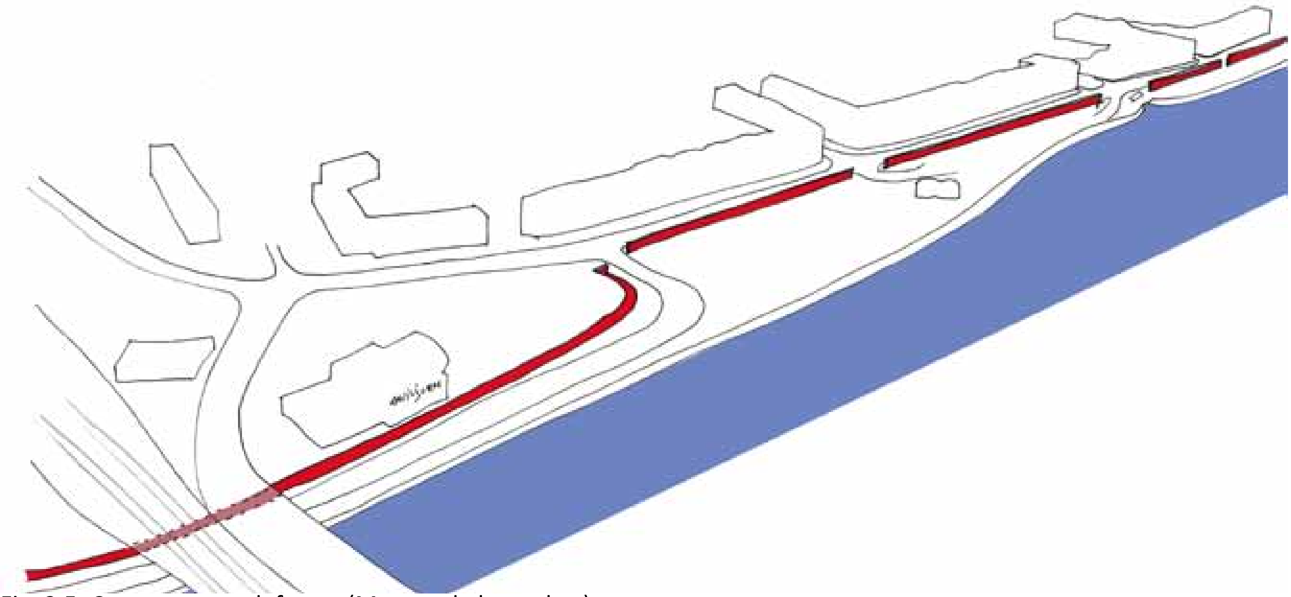


Fig. 3.5: Current water defence. (Map made by author)

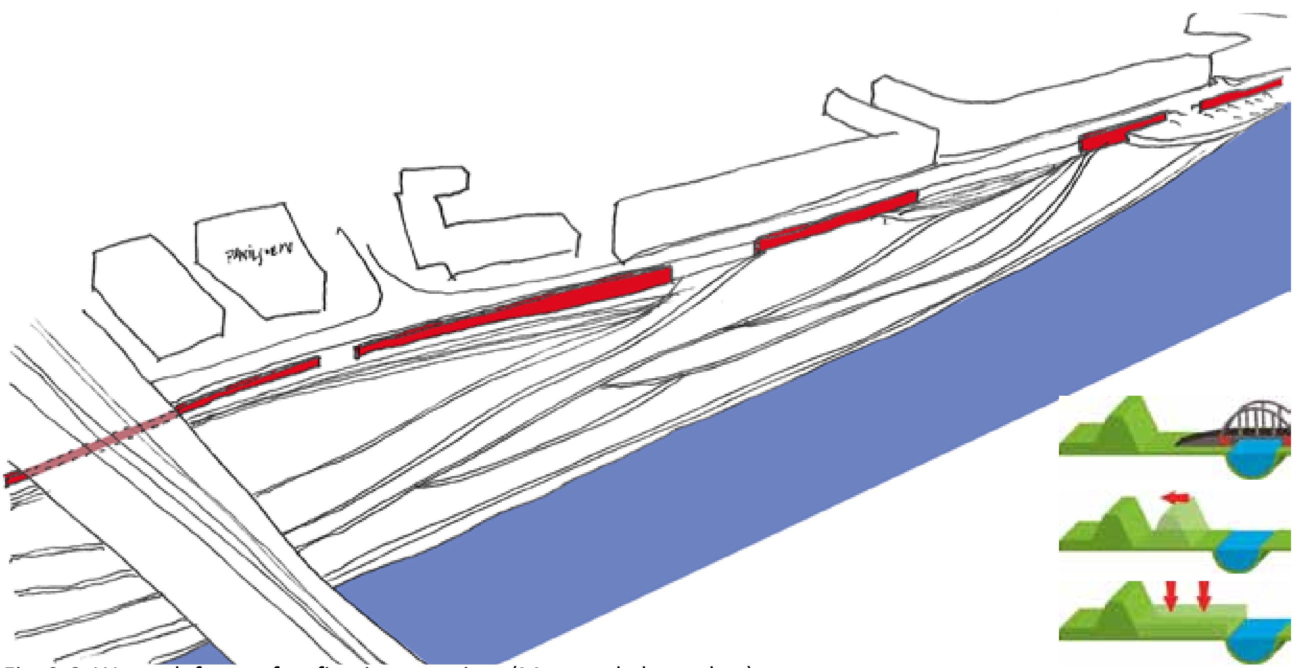
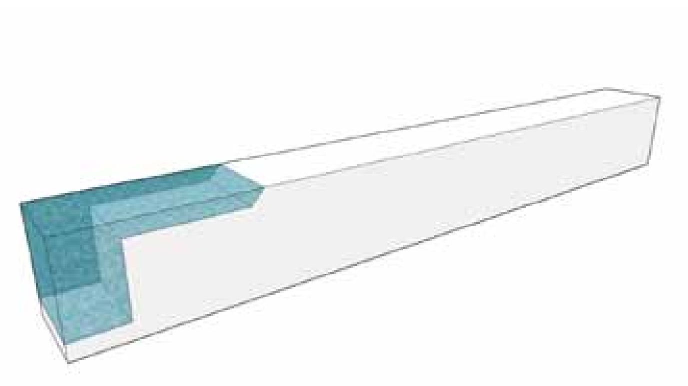


Fig. 3.6: Water defence after first intervention. (Map made by author)



WET AREA (A) = 2006 m^2
TOTAL WIDTH (l) = 318 m

The current profile will be full when there is a flow of 16,000 m^3/s near Lobith.

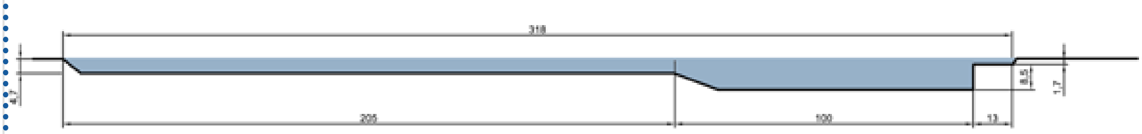
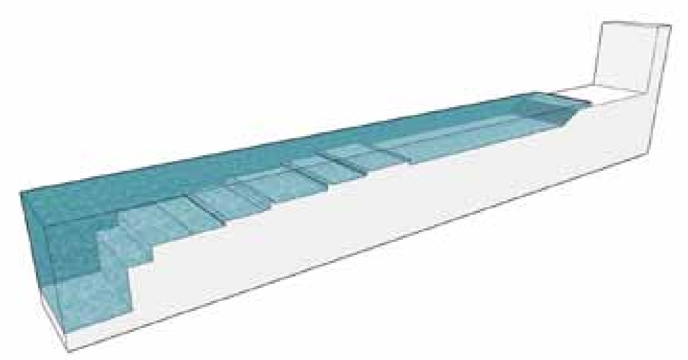


Fig. 3.7: Current profile just south of the bridge. (Maps made by author)



WET AREA (A) = 2119 m^2
TOTAL WIDTH (l) = 355 m

ADDED SURFACE (ΔA) = 113 m^2

During a flow of 16,000 m^3/s near Lobith the water level will be lowered with 32 cm.
$\Delta A / l = \Delta h$
113 m^2/355 m = 0.32 m = **32 cm**

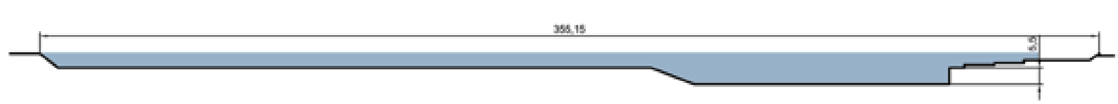
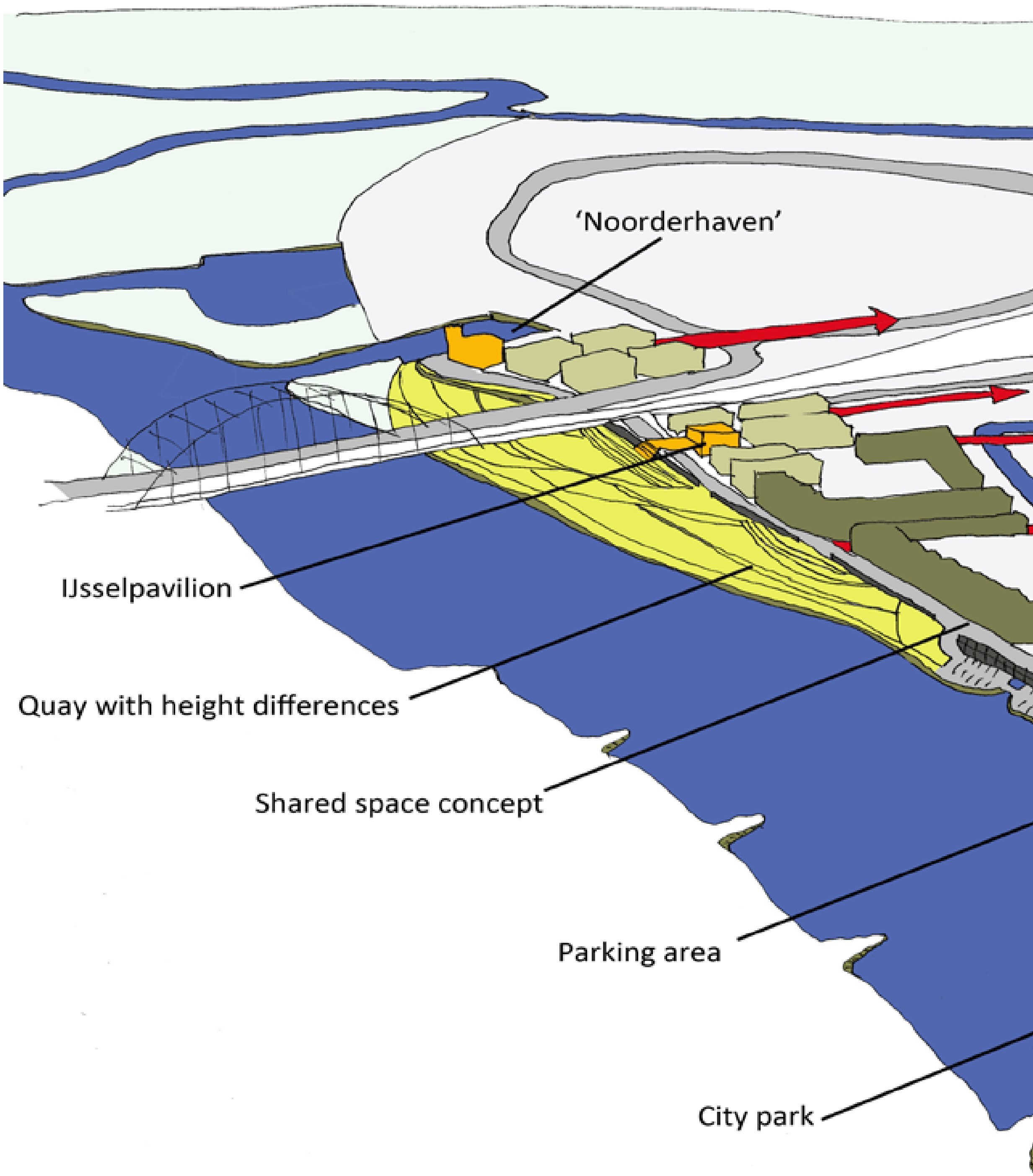
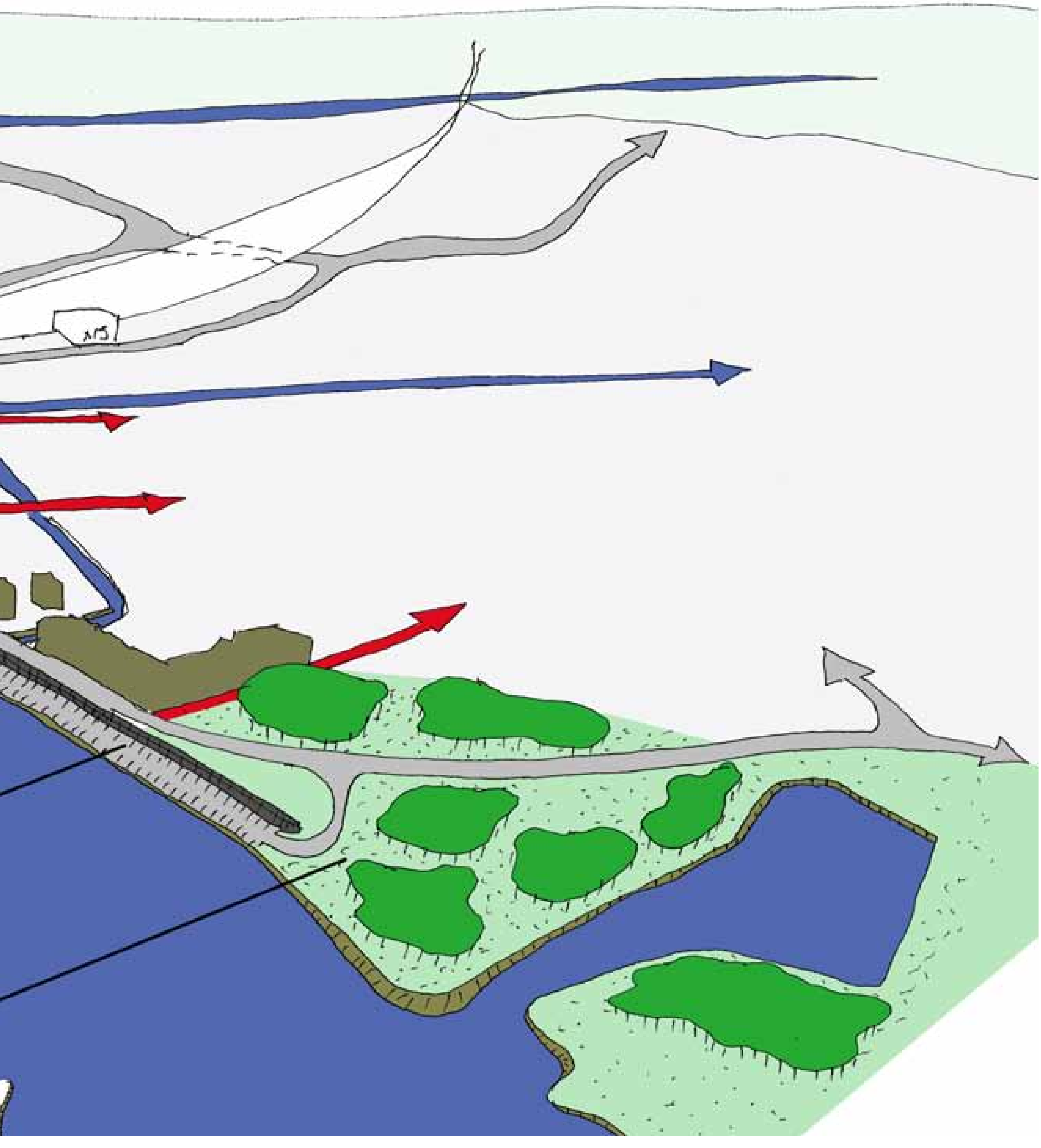


Fig. 3.8: Future profile just south of the bridge. (Maps made by author)

MASTERPLAN


'Noorderhaven'
IJsselpavilion
Quay with height differences
Shared space concept
Parking area
City park



N3

INFRASTRUCTURE

Removing the landing of the bridge asks for a new infrastructural situation. The new road has to be placed inside the dike: otherwise the car bridge can't be used during several periods in a year. There are also some other problems in the current situation (see fig.3.9). The connection to 'De Mars' is a small passageway and is located outside the dike, so during high water this road is flooded (see fig.3.13). The road along the quay is directly connected to the bridge, so it's used as a passageway to the south. This is the main reason that this road is very busy and forms a barrier between the city and the riverfront. For the new situation two options were studied, one with the car bridge on the south side of the train bridge (current situation) and one on the north side.

The second option solves all the current problems and offers most possibilities to strengthen the spatial situation. On both sides of the river, the complex infrastructural knot will disappear and the connection with the new ring road is good. Traffic on the road along the quay will also be reduced. This is better for the pedestrian access to the public riverfront. The disadvantage of this option is that a new car bridge is needed. At the same time, the current bridge already needs renovation, because the bridgehead will be replaced inland. The old car bridge can therefore be used as a slow traffic (cyclists and pedestrians) bridge over the IJssel.

Fig. 3.9: Current situation and problems. (Map made by author)

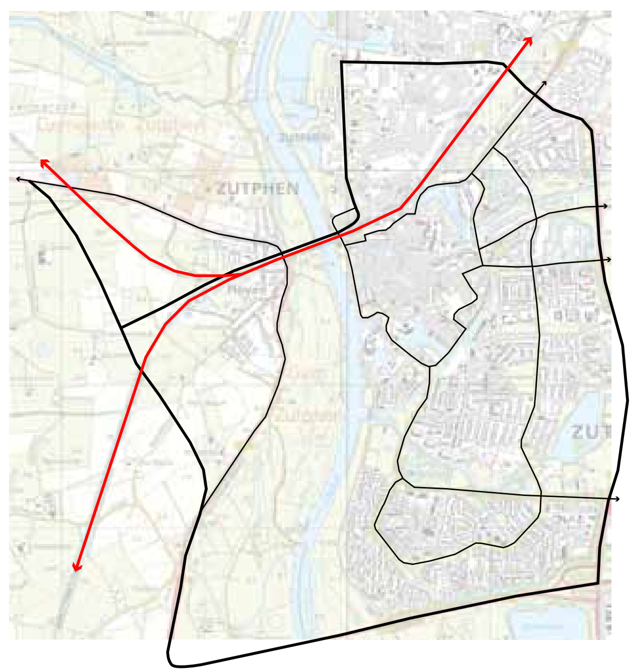


Fig. 3.10: Variant 2 on the larger scale, connections with the new ring road. (Map made by author)

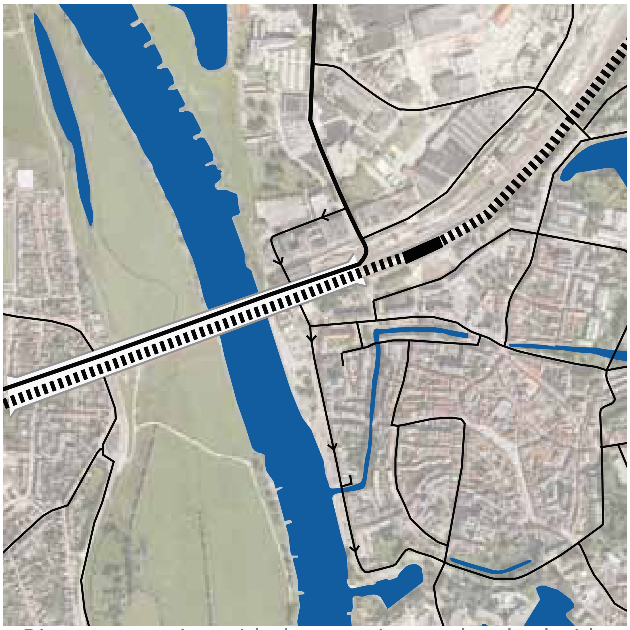
VARIANT 1: SOUTHERN CAR BRIDGE

+ Car bridge can stay on the same side.

- Difficult connection with new ring road on both sides of the river (complex intersections).
- Road along the quay still functions as important passageway.

Fig. 3.11: Variant 1. (Map made by author)

VARIANT 2: NORTHERN CAR BRIDGE



+ Direct connection with the new ring road on both sides of the river.
+ Traffic along the quay will be reduced.
+ Easy access to the parking place of the central station.

- New car bridge on the north side is necessary.

Fig. 3.12: Variant 2. (Map made by author)

Fig. 3.13: Passage to 'De Mars' flooded. (Photo made by author)

IMPLEMENTED DESIGN PRINCIPLES

Redesigning the quay

In the design of the quay, several design principles from the case study are implemented. The whole public riverfront will be differentiated into different zones (see fig.3.13). This way of zoning is also present in Arnhem. Each zone has a different profile and in all the profiles a height difference is included. In the parking zone this is done the same way as in Arnhem. In the terrace- and event zone, this is based on the new quay of Venlo (see fig.3.14) and Hamburg. There is also space available for terraces, which should attract more people to the quay. In Nijmegen and Arnhem (see fig. 3.15) there are also spaces along the river occupied by terraces. In Zutphen this means there should be more restaurants and bars in the historic nineteenth century buildings. The public riverfront is an important connecting factor between the current riverfront and 'De Mars'. That is why the public quay will be expanded to the north. This way of linking different city parts is also applied in Nijmegen.

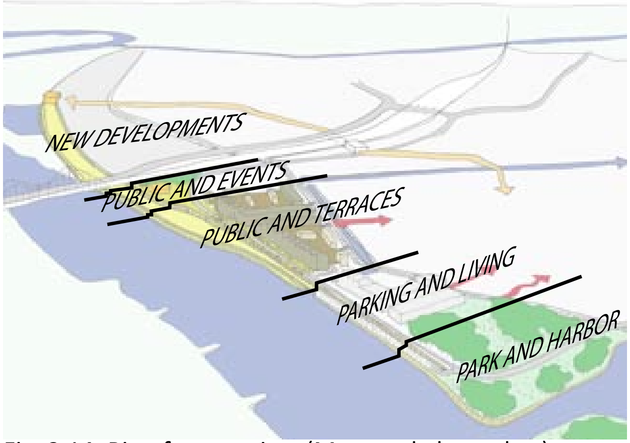


Fig. 3.14: Riverfront zoning. (Map made by author)

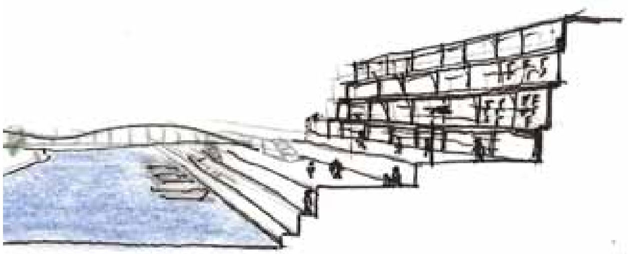


Fig. 3.15: Height differences on the quay in Venlo. (Map made by author)

Fig. 3.16: Terraces in Arnhem. (Source: GoogleEarth)

Fig. 3.17: New quay in Zutphen. (Map made by author)

Destinations

Different activities will be added along the riverfront, with an emphasis on adding functions that are currently not present in the city. That's why a park will be realised around the existing marina on the south side of the quay. In the river cities Nijmegen (see fig.3.18) and Maastricht a recreational park also serves as the end point of the quay. On the other end of the public quay is space reserved for a cultural function: a cinema, theatre or a cultural center. Just as in Arnhem and Maastricht (see fig. 3.17), this building should attract people to the new developed area. The current IJsselpavilion is an important place in Zutphen: everybody knows it , it is an eyecatcher and a meeting point. So this attraction will stay almost in the same place. It is replaced a little inland to create an open link between 'De Mars' and the current riverfront. The pavilion is located in the middle of the new public riverfront, so it will function as a center point in the future.

Fig. 3.18: Centre Ceramique as destination in Maastricht. (Source: www.maastricht.nl)

Fig. 3.19: Valkhof in Nijmegen, park as endpoint of the quay. (Source: www.nijmegen.nl)

Fig. 3.20: Impression of the new marina in 'De Mars' . (Source: www.kcap.eu)

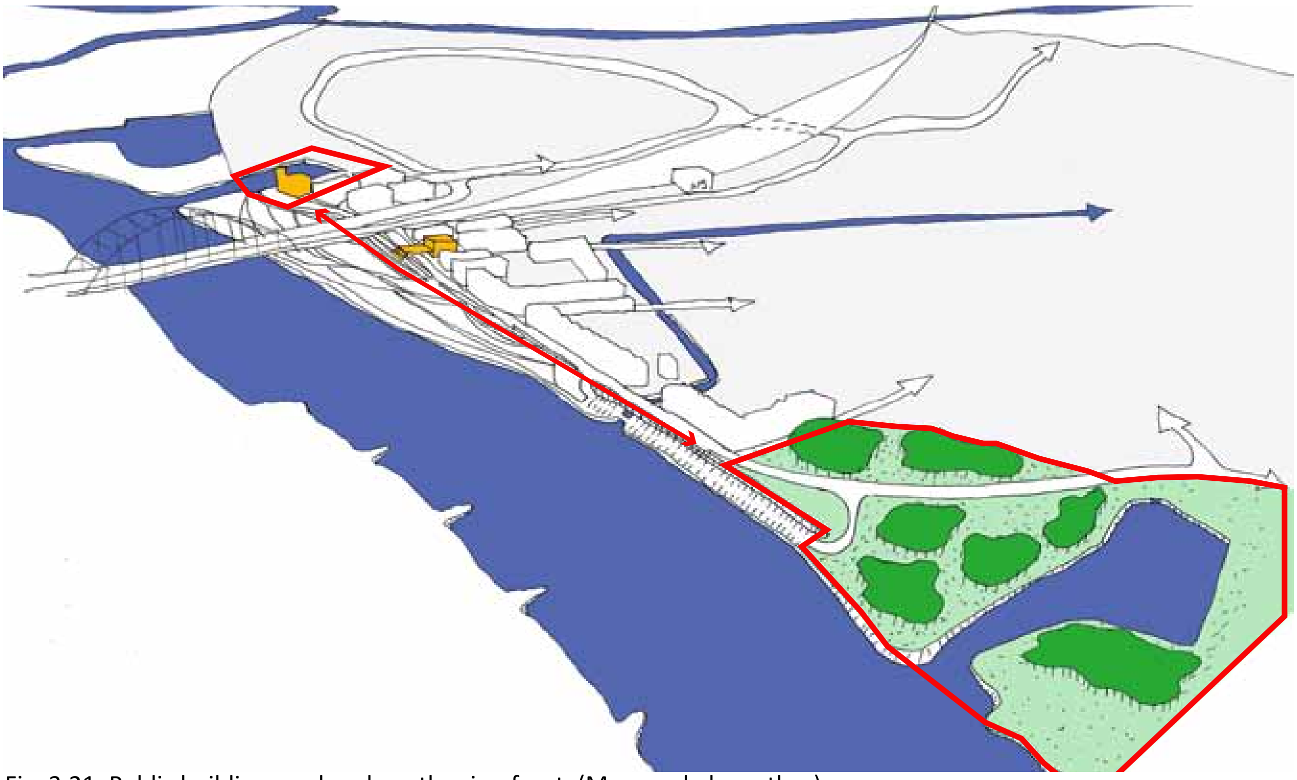


Fig. 3.21: Public buildings and park on the riverfront. (Map made by author)

Connections
For the benefit of pedestrians, it is important to create walking routes through the city (Gehl, 2010). This design principle has been applied in Maastricht with the 'Centre Ceramique' and the new pedestrian bridge. That's why it's not only important to create pedestrian accesses from the city to the riverfront, but also a pedestrian-friendly zone along the riverfront. So for the whole riverfront a shared space is introduced this infrastructural axis has the same materialisation along the whole quay. The same materialisation as the market in Zutphen is used, this innovation is quite new. This way people will recognise the pedestrian-friendly zones.

Fig. 3.22: Example of shared space in Brighton (Source: Gehl, 2010)

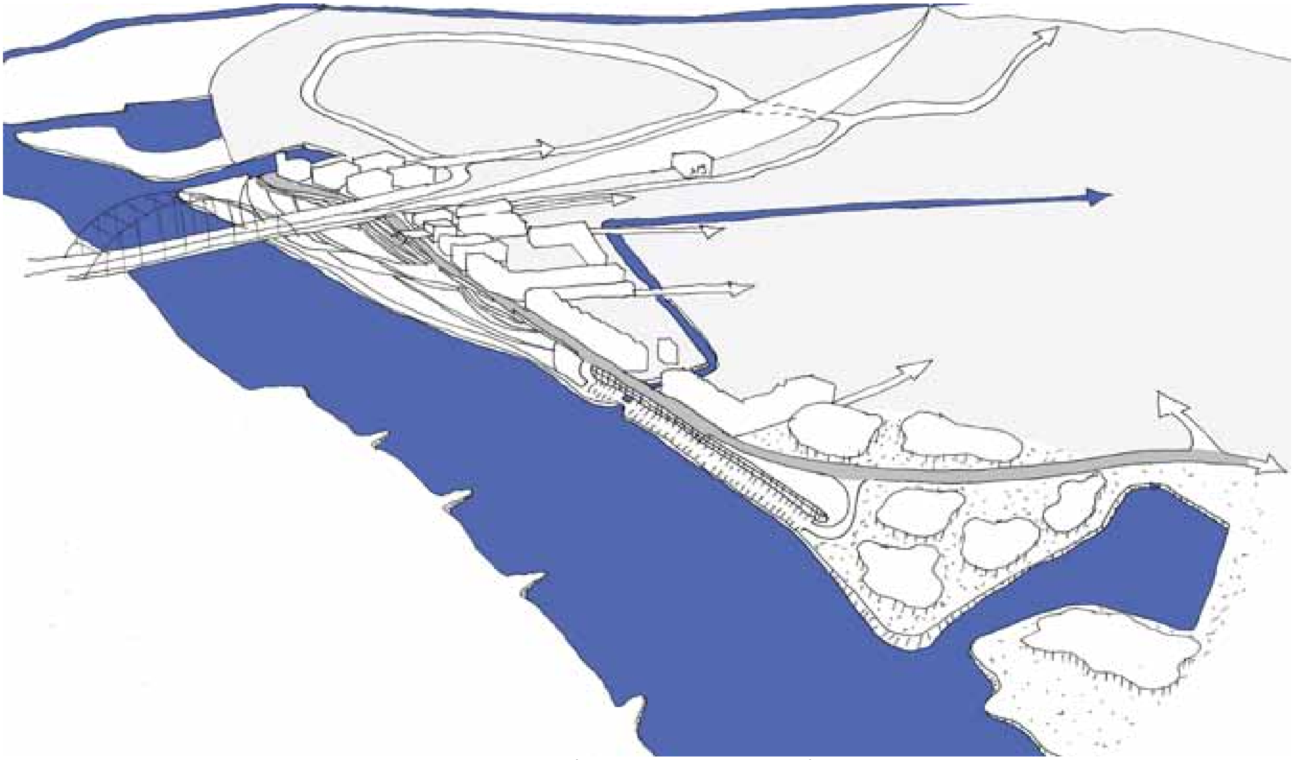


Fig. 3.23: The shared space axis along the riverfront. (Map made by author)

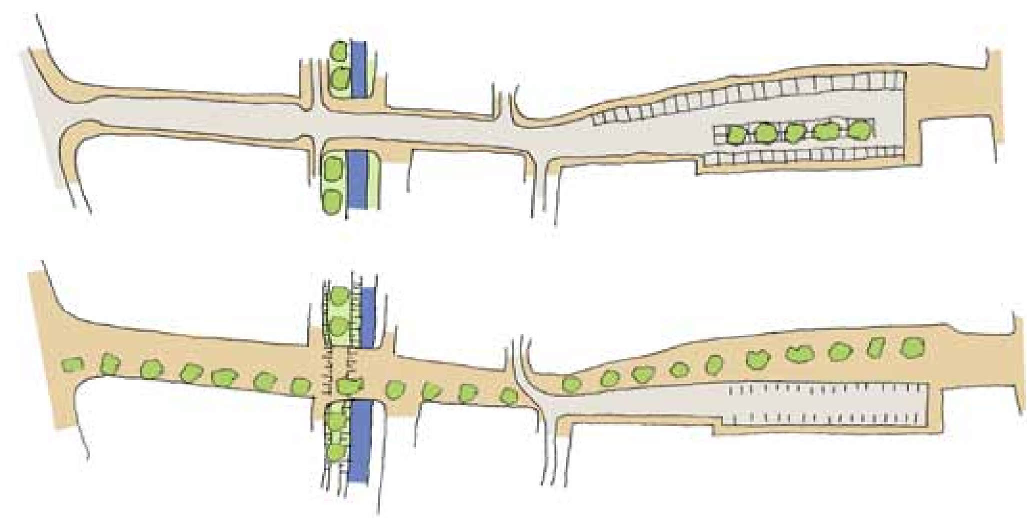


Fig. 3.24: Above the current Marspoort straat and below the new pedestrian friendely street. (Maps made by author)

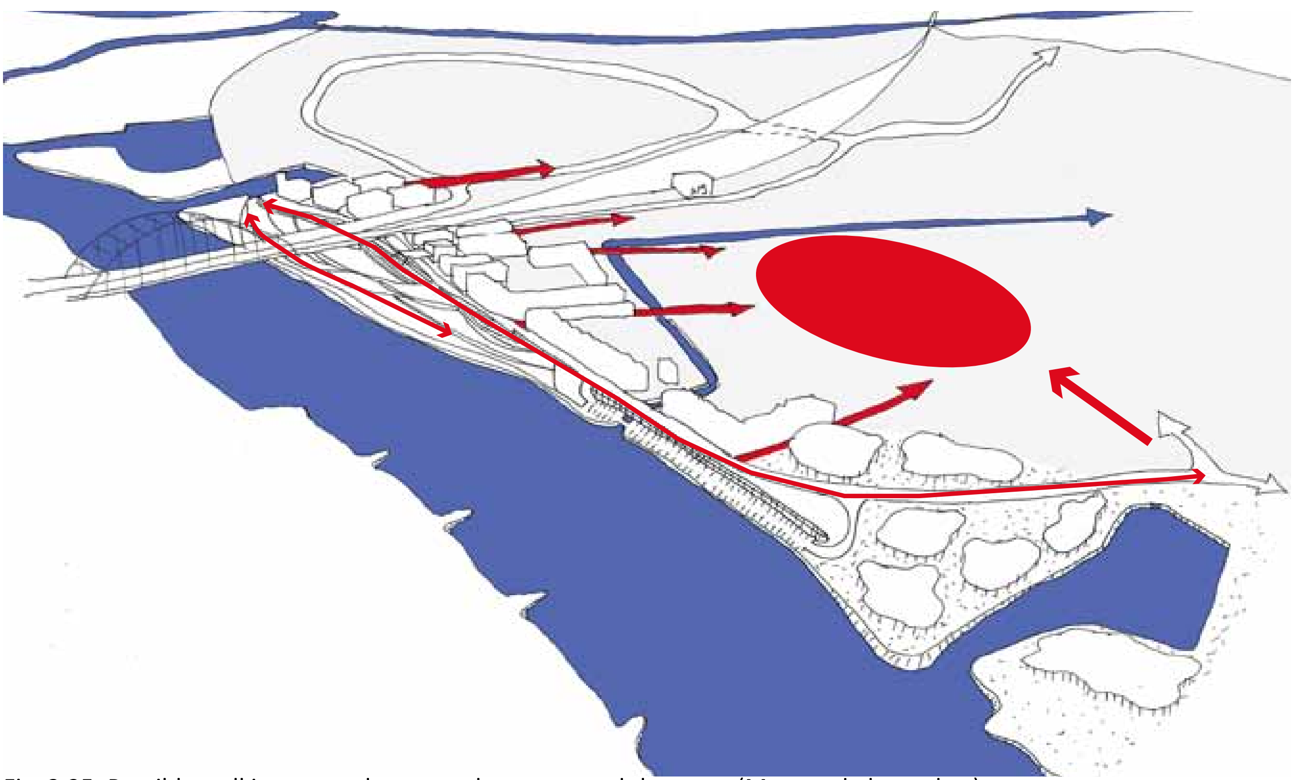


Fig. 3.25: Possible walking routes between the center and the quay. (Map made by author)

DESIGN OF THE RIVERFRONT

The development of the new riverfront of Zutphen can be started in the north, in the 'Noorderhaven'. At this moment the area is already under construction. Together with this intervention it is possible to construct the new bridge. This way the 'Noorderhaven' will be connected to the ring road and it has immediately an open relation with the current quay. When the new bridge is finished it is necessary to realise the shared space all along the quay, otherwise the historic city center is not accessible from the bridge.

Fig. 3.26: First phase of the new quay.
(Map made by author)

Fig. 3.27: First phase of the new quay.
(Map made by author)

When the 'Noorderhaven' has been completed and the new bridge is finished, vacant space is available just south of the rail road. This space was occupied by infrastructure; the landing of the car bridge. The 'IJsselpavilion' will be replaced to this vacant lot. This means that space is created to realise the new public quay and shift the dike back. In the northern part of the riverfront the quay will be wide, this way it creates an optimal link between the two sides of the bridge. By using many small height differences, green elements and curvy lines this profile has an informal character (see fig. 3.30). This also makes it possible to experience the different water levels of the river. In front of the 'IJsselpavilion' a space for events, such as a market or a fair, is created.

Fig. 3.28: The pavilion will be replaced.
(Photo made by author)

Fig. 3.29: Second phase of the new quay.
(Map made by author)

Fig. 3.30: Design for the quay near the bridge. (Drawing made by author)

Fig. 3.31: Hafencity in Hamburg is used as reference
(Photo made by author)

Fig. 3.32: Hafencity in Hamburg.
(Photo made by author)

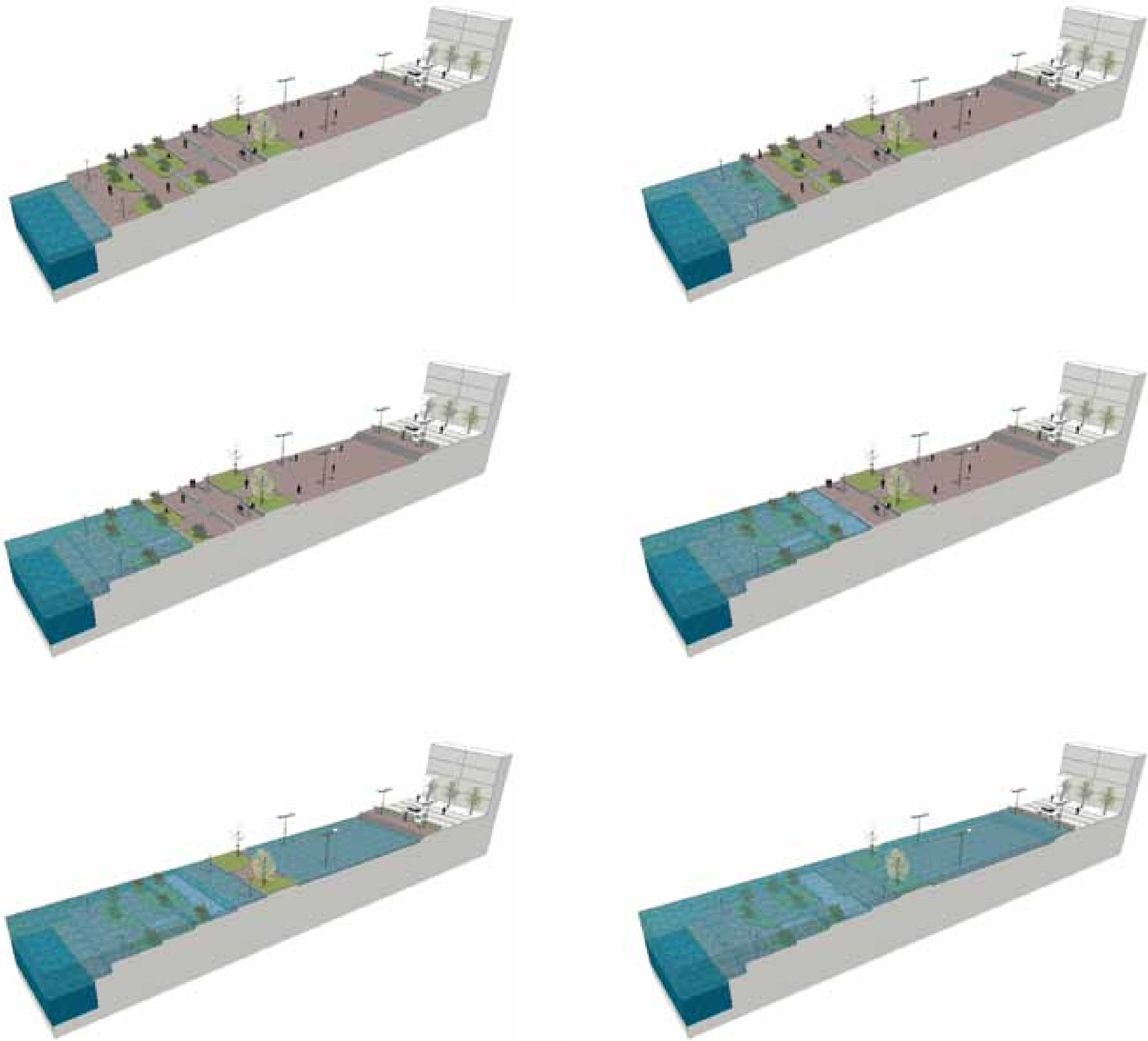


Fig. 3.33: Different water levels on the quay.
(Maps made by author)

In the next phase the rest of the quay will be realised. At the height of the 'Marspoortstraat', the main connection between city center and the riverfront, large stairs will determine the view. Towards the river several height levels will be implemented. Near the historic buildings, space will be created for terraces. This makes it attractive to establish some restaurants and pubs here. This part of the quay will have a harbor character; the area used to function as a harbor and nowadays there are still berth places for ships. The materialisation is based on Hafencity in Hamburg (see fig.3.36). The concrete plates serve as a walking route, this way people with prams and walking frames can also reach the lower levels.
In the area further towards the south the quay has only two levels. The highest level includes the shared space, it functions as a connection to the south. The lower level is occupied by parking places, just like the current situation. This way the riverfront is also accessible by car. The parking level will be lowered in comparison to the current situation.

Fig. 3.34: Third phase of the new quay.
(Map made by author)

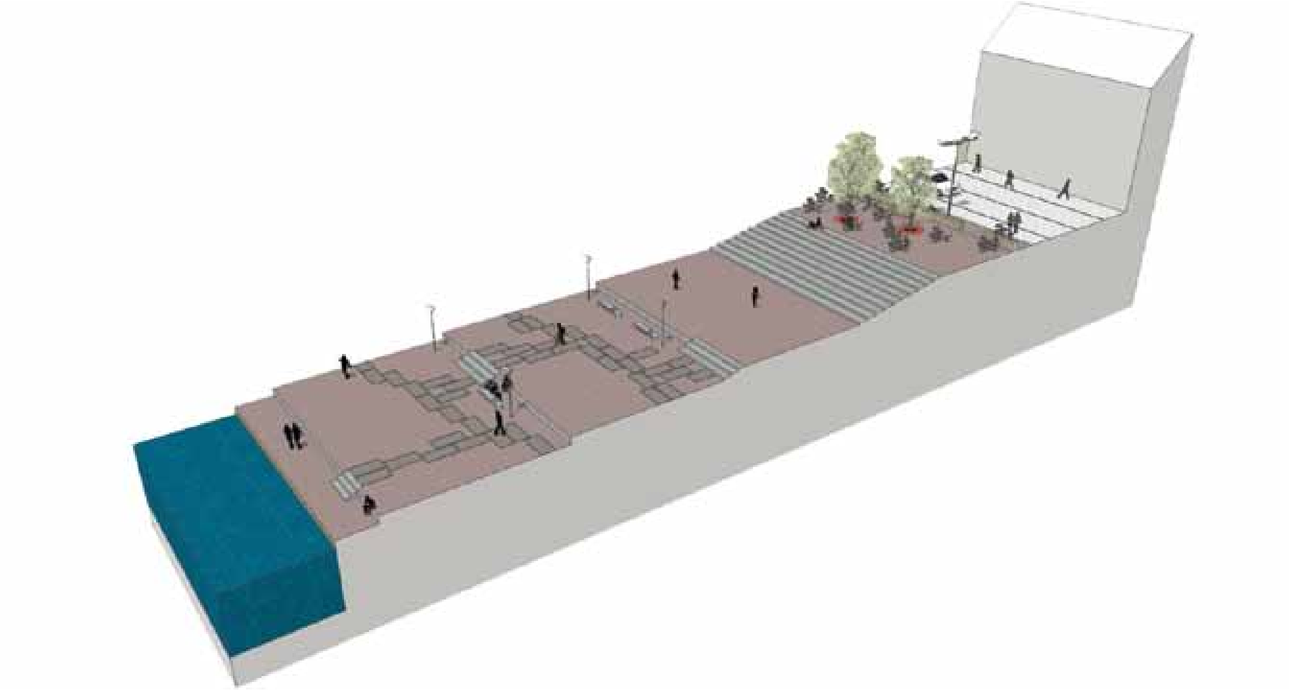


Fig. 3.35: Design for the quay with near the main city entrance.
(Map made by author)

Fig. 3.36: Harbor materialisation of Hafencuty used as reference. (Photo made by author)

Fig. 3.37: Concrete used for pedestrian routes.
(Photo made by author)


Fig. 3.38: Different height levels on the quay. (Drawing made by author)


Fig. 3.39: Space for terraces near the historic riverfront. (Map made by author)

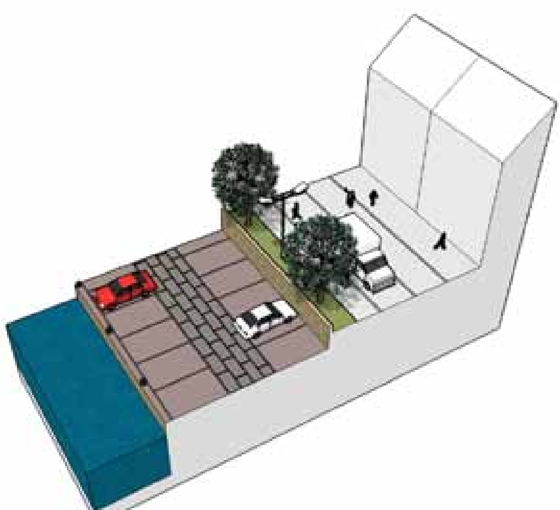


Fig. 3.40: Profile of the parking area. (Profile made by author)

To complete the masterplan it is necessary to create an endpoint on the south side. It is possible to combine the marina with a new city park. At this moment Zutphen lacks a city park, so this will be a valuable addition to the city center. The total riverfront is now framed between two marina's. Figure 3.42 shows the public quay consists of three different parts. The green zone is linked to new buildings, the harbor zone is attached to the historic riverfront and the parking zone relates to the dwellings build in the 60's and 70's.

Fig. 3.41: Third phase of the new quay.
(Map made by author)

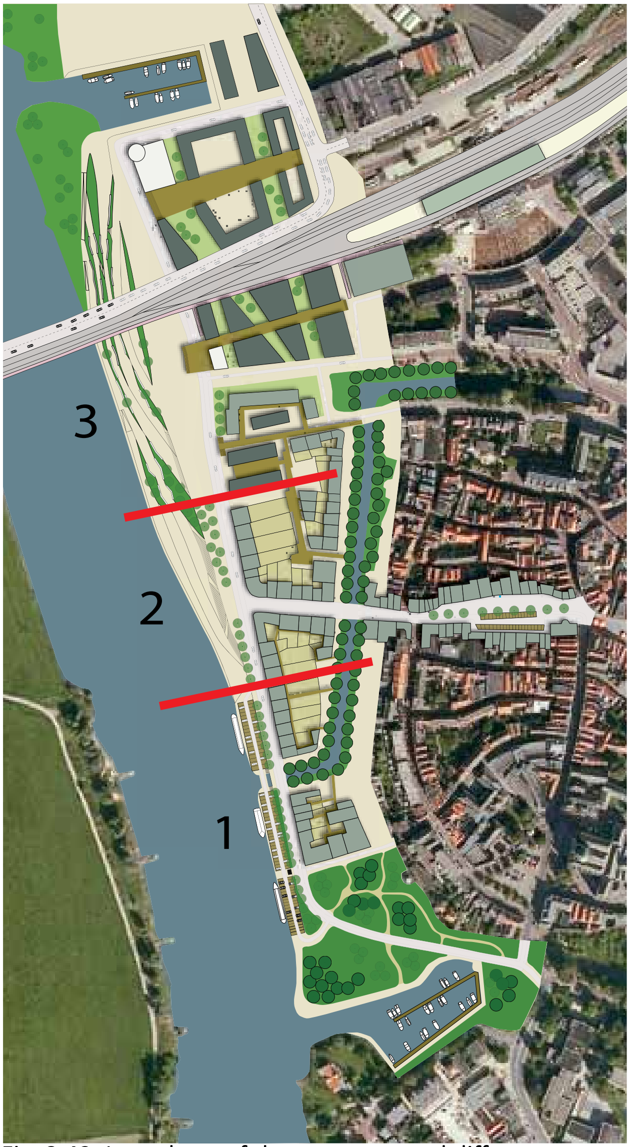


Fig. 3.42: Last phase of the new quay and different zones.
(Map made by author)

NEXT STEPS

After a certain period the water situation should be evaluated. If it is proven that the water defence system will not be sufficient in the future, a few options are possible. In the first place the wall on the quay can be raised. This means that the dikes on the opposite side of the river also need to be raised. There is also the risk of destroying the physical- and visual relation between the city and the river. Another possibility is to replace the water defence to the building line. The buildings need to be water-repellent on the ground level and streets can be closed with plates during high water. This solution is based on the water defence system in Kampen. The buildings can be accessed from the backside. Calculations show that this intervention will reduce the water level with five cm.

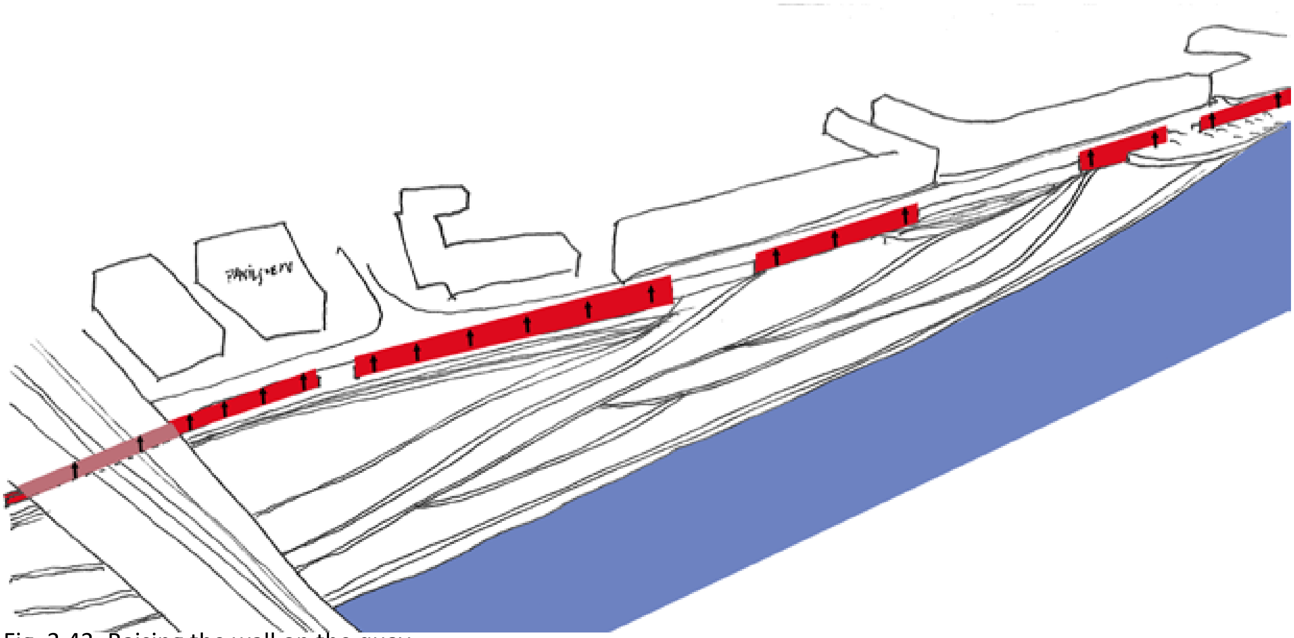


Fig. 3.43: Raising the wall on the quay.
(Map made by author)

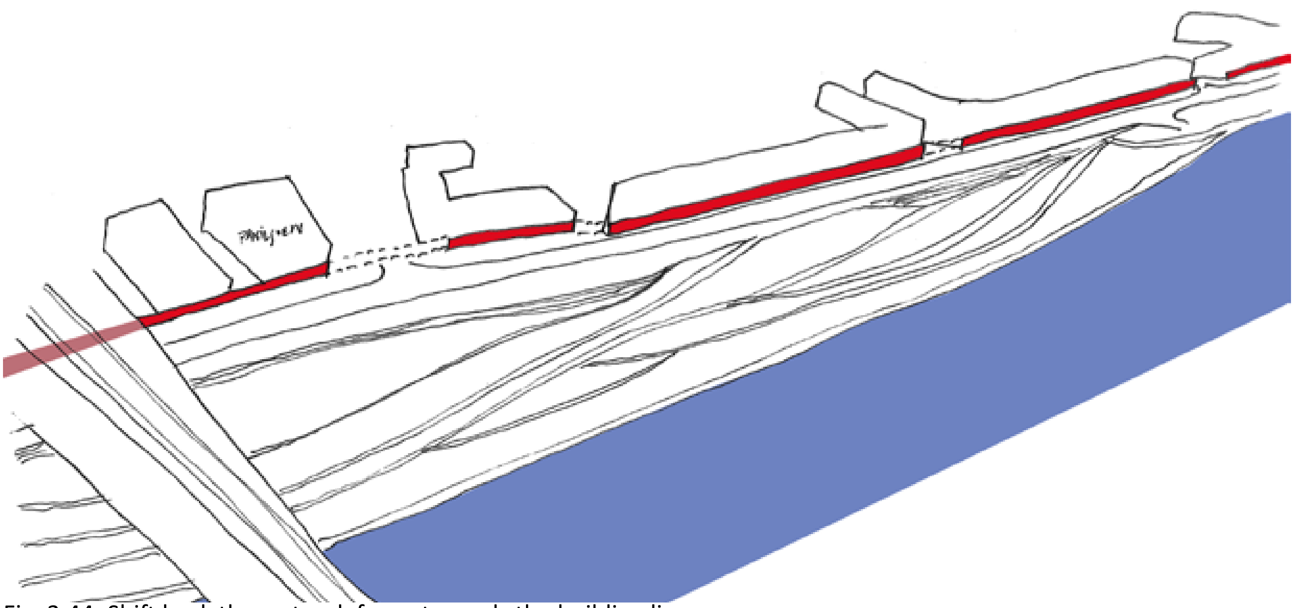


Fig. 3.44: Shift back the water defence towards the building line.
(Map made by author)

To achieve a larger decrease in the water level it is possible to eliminate the water defence on the urban quay. In this option the natural height difference will be used as defence against the water (see fig. 3.46). The new area that can be flooded will function as a catchment area; it will not be part of the flow area. One of the major challenges of this project are the monumental buildings outside the water defence sytem. During high water, some of them will be flooded. Since they're existing buildings, it is impossible to use stilts or floating houses. So the only solution is to make the buildings waterproof on the first level. During high water it won't be possible to access the buildings from the groundfloor, so it's necessary to add a first floor access to the buildings. Figure 3.47 shows how the building blocks are connected to public platforms that are accessible from the area inside the dikes. These platforms are also a new pedestrian access to the riverfront. Inside the building block the public street will be covered by a semi-public platform (see fig. 3.48). Underneath the platform the street can still be used for parking and for access to the buildings and gardens (see fig. 3.50). The platform will function as meeting place and as a safe place for children to play. This way the new construction will add something to the living space of the inhabitants. The connection between the semi-public platform and the buildings can be chosen by the people who live there. Two solutions are possible. The first is a permanent connection; in this option it's possible to widen the walkway for a terrace (see fig. 3.53). The second option is a temporary solution, in which scaffolds will be installed during high water (see fig. 3.54). This solution is based on current techniques for handling high water in Venice.


Fig. 3.45: In red boxes the public platforms. (Map made by author)

Fig. 3.46: The area that can be flooded and a cross section. (Map made by author)

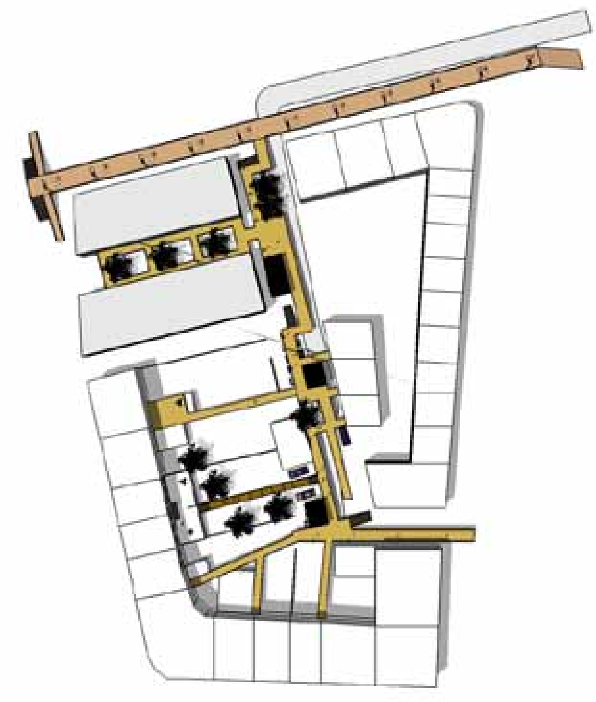


Fig. 3.47: Map of the platforms for one building block. (Map made by author)


Fig. 3.48: Overview of the building block. (Drawing made by author)


Fig. 3.49: Nieuw Terbregge used as reference.
(Photo made by author)


Fig. 3.50: Space for car parking below the platform. (Drawing made by author)


Fig. 3.51: Overview of the building block. (Map made by author)

Fig. 3.52: Connection to the buildings during normal circumstances. (Drawing made by author)

Fig. 3.53: Permanent connection to the buildings.
(Drawing made by author)

Fig. 3.54: Connection to the buildings during high water. (Drawing made by author)

Fig. 3.55: Same system used in Venice.
(Source: travel.latetimes.com)

CONCLUSION AND RECOMMENDATIONS

Conclusion

In this project, the 'Room for the river' solutions are applied to an urban area, so it is important to see these solutions not only in a technical way. The solutions need to be merged into a spatial design. This means that it is not a technical task, but a design task. The result is a plan that not only reduces the water level, but also strengthens the urban structure of the city. The generic water solutions and general design principles from the case study are able to be combined in several ways (see examples on page 81).

At first the idea was to eliminate the total water defence system on the urban quay and use the natural height difference as water protection. This meant that existing (historic) buildings can be flooded during high water. Calculations regarding the water levels showed that a big step in reducing the water level is already possible by only shifting the defence system back on certain places. So technical solutions strengthen the livability of the area. Despite the interesting addition to the city center, the flooding of an existing living area will mainly lead to inconvenience. So the technical approach and the spatial design approach strengthen each other in this project.

Recommendations

In the future it will be worthwhile to study the intervention of flooding an existing city part, because it is an interesting idea to create more space for the river and to link the river with the city. Some problems need to be solved, for example: the buildings cannot cope with high flowrate, after the water is gone rubbish is left behind and how can the intervention add something to the spatial quality?

It is also interesting to study the possibility of implementing the general design principles from this project in other river cities. Research should be about the cooperation between the spatial design principles and solutions for the water level rise. Is it also possible in other river cities to solve the water problems and strengthen the urban structure?

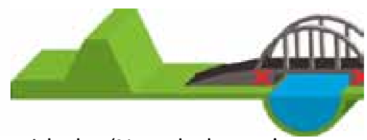


Fig. 3.56: Removing the bridgehead as obstacle in the river creates a better relation with the ‘Noorderhaven’.

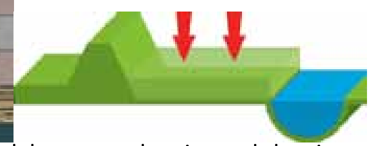


Fig. 3.57: Lowering the quay to add more room for the river also creates a better link between the city and the river.

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Images

Fig. 0.1: Google Earth
Fig. 1.1-1.4: Studio Delta Interventions
Fig. 1.5-1.6: http://www.ruimtevoorderivier.nl
Fig. 1.10: Meyer et al., 2010
Fig. 1.11: Gehl, 2010

Fig. 2.17: http://www.kcap.eu
Fig. 2.27: http://www.rijnboog.nl

Fig. 3.1: Meyer et al., 2010
Fig. 3.4: http://www.ruimtevoorderivier.nl
Fig. 3.16: Google Earth
Fig. 3.18: http://www.maastricht.nl
Fig. 3.19: http://www.nijmegen.nl
Fig. 3.20: http://www.kcap.eu.nl
Fig. 3.22: Gehl, 2010
Fig. 3.26: http://www.kcap.eu.nl
Fig. 3.41: http://www.nijmegen.nl
Fig. 3.55: http://travel.latetimes.com

Fig. A.1: Groothedde and Krijnen, 2008
Fig. A.2: Frijhof, 1989
Fig. A.3-5: Groothedde and Krijnen, 2008

Fig. C.1: Google Earth
Fig. C.2: http://www.watwaswaar.nl
Fig. C.5: http://de.wikipedia.org/wiki/Bremen
Fig. C.6: http://www.blog.medievalchester.ac.uk
Fig. C.7: http://de.wikipedia.org/wiki/Emmerich_am_Rhein
Fig. C.8: http://de.wikipedia.org/wiki/Mainz
Fig. C.9: http://de.wikipedia.org/wiki/Rees

Fig. D.2: http://www.arnhem.nl
Fig. D.3, D.9: Google Earth
Fig. D.12, D.14, D.18: Variantenstudie Havenkwartier, 2009
Fig. D.20, D.25: http://www.maastricht.nl
Fig. D.21: Google Earth
Fig. D.26: http://www.centreceramique.nl
Fig. D.28: Google Earth
Fig. D.29, D.34, D.36: http://www.nijmegen.nl
Fig. D.37: http://www.waalsprong.nl
Fig. D.39: Google Earth
Fig. D.40: http://www.venlo.nl
Fig. D.45: http://www.maasboulevard.nl

APPENDIX A HISTORICAL MAPS

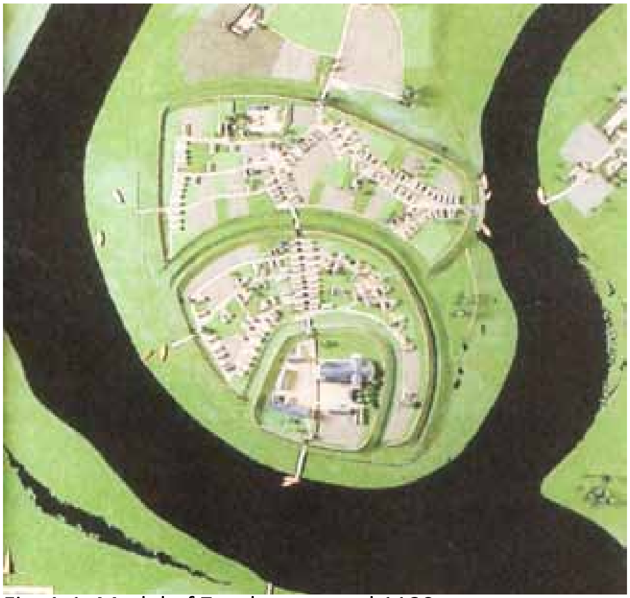

Fig. A.1: Model of Zutphen around 1180.
(Source: Groothedde and Krijnen, 2008)

Fig. A.2: Map of Zutphen around 1565 made by Jacob van Deventer. (Source: Frijhof, 1989)

Fig. A.3: Map of Zutphen around 1649 made by Johan Blaeu.
(Source: Groothedde and Krijnen, 2008)

Fig. A.4: Map of the plans of F.H. Etteger around 1880.
The pattern of the houses between the city and the harbor are seen on the left side.
(Source: Groothedde and Krijnen, 2008)

Fig. A.5: Aerial overview of the city just before the Second World War, the area between the old city and the quay is totally occupied. (Source: Groothedde and Krijnen, 2008)

APPENDIX B THEORY PAPER

Waterproof urban river areas *Leon Hietbrink*

Waterproof urban river areas

Link between the river and the urban public space

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7th Graduation Lab Urbanism Conference

January 26th 2011

Abstract – The river cities in the Netherlands are facing new problems with high water levels due to an increase in river discharges in the next century. More room for the rivers must ensure a lowering in the predicted high water levels, in urbanised areas it is difficult to find these spaces. Raising the height of the dikes is also difficult, because it destroys the connection between the city and the river. On the other hand river cities are trying to (re)create an open relation with the river. This means there is tension between flood protection and urbanisation, both claim the same space.
Since the seventies and eighties river cities rediscovered their relationship with the river (Hooimeijer et al., 2005 and Meyer et al., 2006). At the beginning of the twenty-first century people realised an interrelationship between hydraulic engineering and urban- and landscape planning was necessary to create an optimal relation between the river and the city and make flood defence systems sufficient.
My literature research focuses on various approaches where these different fields of interest are combined to a comprehensive approach (Sijmons, 1998; Hooimeijer et al., 2005; Meyer et al., 2010; Stalenberg, 2010 and others). I have explored the consequences for the spatial value and flood defence systems of interventions derived from these approaches. From the theories behind the interventions I will use guidelines which will eventually result in spatial interventions in my graduation project.

Key words – urban riverfront; spatial relation river and city; flood defence systems; spatial value; room for the river; urban river landscape

1 Introduction: living together with water

Due to climate changes the water level in the Dutch rivers will rise in the next century. The current water management and flood defence systems are not able to deal with this increase in river discharge. Not only the probability of a flood has increased, the consequences are more serious. Due to economic development and the rise in population in the last century, a flood will cause more economic and social damage (Stalenberg, 2010). The Delta committee (2008) recommends measurements in most parts of the Dutch river landscape. This new battle against the water will be different than the ones the Netherlands fought before.
Ham (2002) describes four different ways of dealing with water through history. First the people accepted the water; they accepted the quirks and whims of the rivers and lived on higher, safer grounds. After the year 1,000 A.D. people in the Netherlands started with building defence systems against the water, in this phase the first dike rings were built and the dam-cities arose. The third phase between 1600 and 1800 was a conquest against the water; people tried to change the watercourses and claimed land. The last two centuries are characterised as a manipulative period. Technical developments made it possible to control water levels almost completely and water management was professionalised. In the cities the watercourses lost their transport function and were a threat to public health as disease carriers. A consequence was that many canals and harbors were filled, the water disappeared almost completely from city life. In the last decade of the twentieth century people rediscovered the water again, a more open relation with the water was created at the expense of safety. This process resulted in floodings of the rivers and the water defence system was no longer sufficient (Hooimeijer et al., 2005). Together with the climate changes a change in the hydraulic system had to be made. Heightening the dikes and obtaining control over the rivers were no longer desirable, this led to high water levels and interrupted urban developments. The new policy is to give more space to the dynamics of the rivers, with the aim to lower the water levels ("Projectorganisatie: ruimte voor de rivier," 2007).

- 1 -

Especially around urbanised areas this causes problems, there is not much space for the river because of urban developments in the water meadows. These urban bottlenecks are causing extra high water levels, so at the places where interventions are most needed it is most difficult to intervene. 'Once again urban planning, landscape design and hydraulic engineering will have to deal with each other. This means new problems, new opportunities as well as possibilities for the spatial design of city and country' (Hooimeijer et al, 2005, p.15). Civil engineers, urban planners and landscape architects have to work together to keep the land dry and improve the spatial quality. The challenge is to combine the interests of water management and spatial design in a way that they reinforce each other. The aim of this paper is to find out which approaches there are for this new challenge, which theories support these approaches and how do they deal with the different interests.
In the second chapter the theories and results are explored when landscape design is used as leading principle in spatial design (Sijmons, 1998; Hooimeijer et al., 2005; Meyer et al, 2010). The third chapter studies the approaches and consequences for urban design as leading principle (Trancik, 1986; Hooimeijer et al, 2005; Huisman, 2006; Meyer et al., 2006). The fourth chapter describes the theories and approaches when water safety is the dominant factor in spatial planning ("Projectorganisatie: ruimte voor de rivier, 2007; Meyer et al., 2010; Stalenberg, 2010;). Conclusions and recommendations are given in the last chapter.

2 Landscape as leading principle

The first renewed interests in the significance of rivers in spatial design already came up in the 1970s and 1980s. This turnaround led to changes in landscape- and urban design and in hydraulic engineering (Meyer et al., 2010). Ecological and cultural-historical reasons formed the basis for the rediscovery of water in landscape developments. The constructions of huge dikes resulted in the disappearance of transitional zones between the environments inside and outside the dike (Hooimeijer et al., 2005). These transitional zones contained unique ecological areas and important cultural-historical elements.

2.1 First things first

Sijmons (1998) concludes that new landscapes can be (re)shaped if a coherent hierarchy for design decisions is used. The hierarchy model is divided into three layers, which show the different levels of importance in spatial design. In other words, to create a new landscape it is just a matter of 'first things first'.
The hierarchy model is as follows (Sijmons, 1998; Meyer et al., 2010): the bottom layer is the most important layer, it contains the soil and the water. Regulation of land and water is a precondition for the Netherlands. This layer should provide solutions for the river discharge and sea level rise. The infrastructural layer is the second layer, which includes all networks for roads, railway tracks, waterways and spatial nodes. This layer must create conditions for the third layer, the occupation layer. The top layer includes residential- and business areas, agricultural functions, cultural facilities et cetera .

2.2 Casco approach

To achieve the goal of recreating transitional zones Sijmons (1998) suggests interventions should be done in the bottom layer. This is because changes have to be made in the flood defence system, more subtle forms of dike structures are needed (Hooimeijer et al., 2005). Developments in this bottom layer take a long time, sometimes up to more than one hundred years. These slow developments are interrupted by the fast developments in the top layer. The casco approach is based on the decoupling of high dynamic functions (e.g.: intensive agricultural farming) and low dynamic functions. The green- and blue functions in the bottom layer should be bundled in a cohesive framework where they have time and space to develop, without being disturbed by interventions in the top layer. These fast developments get their own spaces where they have their needed freedom in flexibility. The agricultural areas must be flexible in dimensions and water management. This flexibility is necessary, because high dynamic functions change fast and are hard to predict (Sijmons, 1998).
Disadvantage of this approach is the absence of urban landscapes in the theory. 'The framework only serves to counterpoise the urban sphere of influence and the demands that emanate from it' (Hooimeijer et al., 2005, p.121). The city- and river landscape both use the same land and are part of the same water system, so to come to a complete approach urban development must be included (Hooimeijer et al., 2005).

3 Urban design as leading principle

In the same period cities (the inhabitants and policymakers) developed a new interest in rivers. 'Space only becomes place when it is given a contextual meaning derived from cultural or regional content' (Trancik, 1986, p.112). Cities realised that the river was part of the cultural and regional context. Huisman (2006) states that water in the city contributes to the spatial quality, which results in increase in livability and attractiveness for inhabitants. Ensuring an open relation with the water can be used as city branding, which makes the intervention economically attractive. When water management is also taken into account new interventions will lead to a more sustainable city

(Huisman, 2006). Nevertheless, the main reason for new developments is the increase of spatial value.

3.1 Water as design tool

Hooimeijer et al. (2005) advocates new flexible forms of urban development which are part of the dynamic river landscape. Although the hierarchy model already made clear that areas outside the dikes should be free from urban growth, many urban expansions took place in these environments (Meyer et al., 2006).
Residential areas were created on riverbanks, old industrial areas and in water meadows. These areas close to the water were an important part of the identity of cities (Hooimeijer et al., 2005 and Meyer et al., 2006). To keep these new residential areas safe from water, measures had to be taken. In many cases the ground level was raised. This meant space for the river was taken by urban functions and bottlenecks in urban river areas became smaller. There were also more subtle forms of urbanisation in the river basins. To take up less space from the river, mounds were reintroduced and in some places were experiments with floating houses. Another experiment in the outside dike areas were the waterproof buildings, in these buildings the ground level was able to flood (Hooimeijer et al., 2005). These new urban developments were possible due to a more liberal attitude from water boards. Unfortunately the consequence was that several floods or near floods occurred at the end of the twentieth century. This made the different departments realise that the interrelationship between civil engineers and urban planners had to be changed.

3.2 Control from the top

Sijmons (1998) and Meyer et al. (2006) conclude that in the last century spatial planning was the dominant factor. In the first place residential expansions, business areas and infrastructures were planned. The hydraulic system had to be adjusted to these developments. Many expensive, technical applications were needed to keep the land safe. When water becomes more important in urban life and cities want a more open relation with the river, water management should be controlled from the top. National government must create a hydraulic map that functions as a guide for local- and regional urban planners (Sijmons, 1998).

4 Water safety as leading principle

National policy created a programme where the principle is to make more space for the rivers instead of raising the dikes. This time from the point of view of water safety, because the aim is to lower the high water levels. An advantage of this method is the possibilities for urban- and landscape developments (Meyer et al., 2010). The programme supports the idea of 'working with nature', but does not say how to implement this approach. It pays attention to the hydraulic- and environmental topics, but not for the consequences for urbanisation. 'There is no broad or coherent consensus about how to relate new methods of flood defence and water management to issues such as urbanisation, economic development, and changing land use in agricultural areas.' (Meyer et al., 2010: p: xiv). The task is to find out which comprehensive approaches satisfy all interests.

4.1 Room for the river

The '*Ruimte voor rivier'* programme created a set of hydraulic interventions, such as lowering groins, making bridgeheads permeable, digging out floodplains, shifting dikes back and constructing flood bypasses. The Dutch government assigned these solutions to certain areas of the river, together with the task of determining how much the water level must be lowered. In these areas local and regional governments can link these interventions to housing, recreation and waterfront development ("Projectorganisatie: ruimte voor de rivier, 2007). This way of working uses the hierarchy model; the interventions in the bottom layer are most important, changes in the second- and third layer have to adjust to these interventions.
One of the original goals of the program was to combine flood defence systems with housing, but this combination does not seem relevant anymore. It turned out that housing in the intervention areas were not economically feasible. But the hydraulic interventions revitalised and enriched the relation between the urban area and the river. This is because the projects kept elements in mind, such as physical connections to the water, recreational functions, riverbank quality, smart reservation areas and the orientation and identity of the cities. (Meyer et al., 2010). This shows that it is not always necessary to build closer to the river to create a better relation between water and urban landscape. In urbanised river areas there is not always space for the river, so when there is no room for the river or it is not economically feasible, dike heightening remains the only solution. Especially in urbanised areas it is difficult to heighten the dike, because the dike is embedded in the urban pattern. In many cases cities along the river have historic riverfronts, too valuable to demolish or cut off from the river. In the case of Kampen a flexible solution was found to heighten the flood defence system and keep the historic riverfront intact. The houses on the waterfront are made waterproof on the ground level and only when high water occurs streets are closed off with plates. During normal water levels the city maintains its visual relation with the river. Hooimeijer et al. (2005) wonders if this flood defence system will still be sufficient when the water level keeps rising in the future. Another complaint is that the intervention does not add any

spatial value. In this case the flood defence is strengthened and it did not do damage to the urban pattern. A solution must be found where both elements are strengthened. This is why Hooimeijer et al. (2005) proposes to take a look at the rear side of the city and the possibilities to create a green river here. With this solution the water level can be lowered and the spatial quality of the surrounding urban areas will be increased.

4.2 Adaptable flood defence systems

New research showed the river discharge will increase even more than expected (Meyer et al., 2010). This means water levels have to be lowered even more or dikes have be strengthened and heightened. In urbanised areas this means raising the dikes is the only solution. One of the proposed solutions is the superdike. These dikes take up large spaces along the river and they contain buildings, infrastructural works and parking facilities. This way they have the possibility to add something to the spatial value, but fact is that they also destroy spatial relationships and historical and cultural urban areas (Meyer et al., 2010).
Stalenberg (2010) suggests that freedom in the transformation process is desired. Unfortunately, both improvement of flood defence structures and the (re)development of urban riverfronts are extremely difficult. The aim is to find a solution for the difficulties in improving the flood protection structures and the (re)development of an urban riverfront. Is it possible to create and maintain synergy in an urban riverfront between the technical function of flood protection and urban functions? The solution proposed by Stalenberg (2010) is a concept called Adaptable Flood Defence (the AFD concept). It creates physical synergy by providing innovative structures which combine urban functions and the technical function of flood protection into a multifunctional structure. Urban functions as parking, buildings, dwellings and roads are possible (see illustration 1). The multifunctional element makes the flood defence an improvement for urban quality instead of degradation. The adaptability enables flood controllers to cope with uncertainties of external influences as climate change or economic change. The adaptability also enables urban planners to anticipate on changes in desires of urban activities.
If the AFD concept is applied this to an existing (historic) riverfront the multifunctional flood protection will still disrupt spatial relations between the city and the river. That is why Hooimeijer et al. (2005) advocates another approach for the development of urban riverfronts. The theory proposes an innovative way of function integration that is also relevant for new urban centers and riverfronts. Dike strengthening should be combined with city development to get the urban riverfront out of its cramped situation. In this approach the lineation of the urban front and the course of the river have to stay intact. The new developments must be a logical step in the historical development of the city. This means monumental elements must be interwoven in the future urban front. This new riverfront must play a role in restoring the awareness of attractiveness and dangers of the river, so the riverfront must provide contact with the river during normal circumstances and during high water. This approach uses the water task put forward by the Dutch national government and combines it with urban riverfront development to increase the value of the flood defence and the spatial value.

5 Conclusions

Many researchers and designers pay attention to the significance of rivers in urban life. In some cases they only pay attention to the urban problems and neglect the problems in flood defence and water management. This approach of putting spatial development on the first place has resulted in floods and dangerous situation. Nevertheless, most approaches realise water safety is a main condition to make further urban developments possible. This

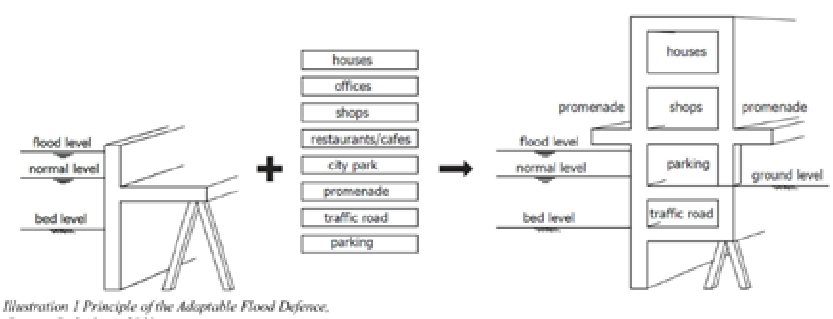

Illustration 1 Principle of the Adaptable Flood Defence. Source: Stalenberg, 2010.

does not mean measures in flood defence and water management can neglect processes in urban design. The hierarchy model of Meyer et al. (2010), here called the 'layer cake model', suggests interventions on the bottom layer are most important (see illustration 2). These interventions affect the second- and third layer and these effects have to be taken into account when there is an intervention in the bottom layer.
For the short term (2015) solutions have been found that strengthen the hydraulic situation and maintain the spatial value. But the task for the future is to come to a comprehensive approach that improves the flood defence system, protect the environment and create high-quality urban development and attractive landscapes (Meyer et al., 2010). The 'state of the art' thinking is a development in progress; research is still being done to find this comprehensive approach.

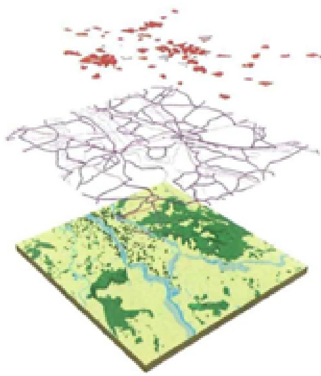

Illustration 2 The 'layer cake model'. Source: Meyer et al., 2010.

6 Recommendations

In the river IJssel measures are needed to maintain water safety, the urbanised area of Zutphen functions as a bottleneck. At the same time the local government tries to (re)create relations with the river, by adding functions and developing its historic waterfront. This theory paper put my graduation project in a broader perspective. The hierarchy model proves that measures in water safety form the basic conditions for urban- and landscape development. Elements of the approaches and examples in this theory paper can be used for the case of Zutphen, guidelines can be drawn from them and they will lead to spatial interventions in my graduation design.

Acknowledgements

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APPENDIX C QUICK SCAN

Fig. C.1: Overview of the city.
(Source: Google Earth)

Fig. C.2: Historic map of the city.
(Source: www.watwaswaar.nl)

City information

Inhabitants\ ...
River\ ...
Lenght riverfront\ ...
Location inner-city\ ...
Opposite riverbank\ ...

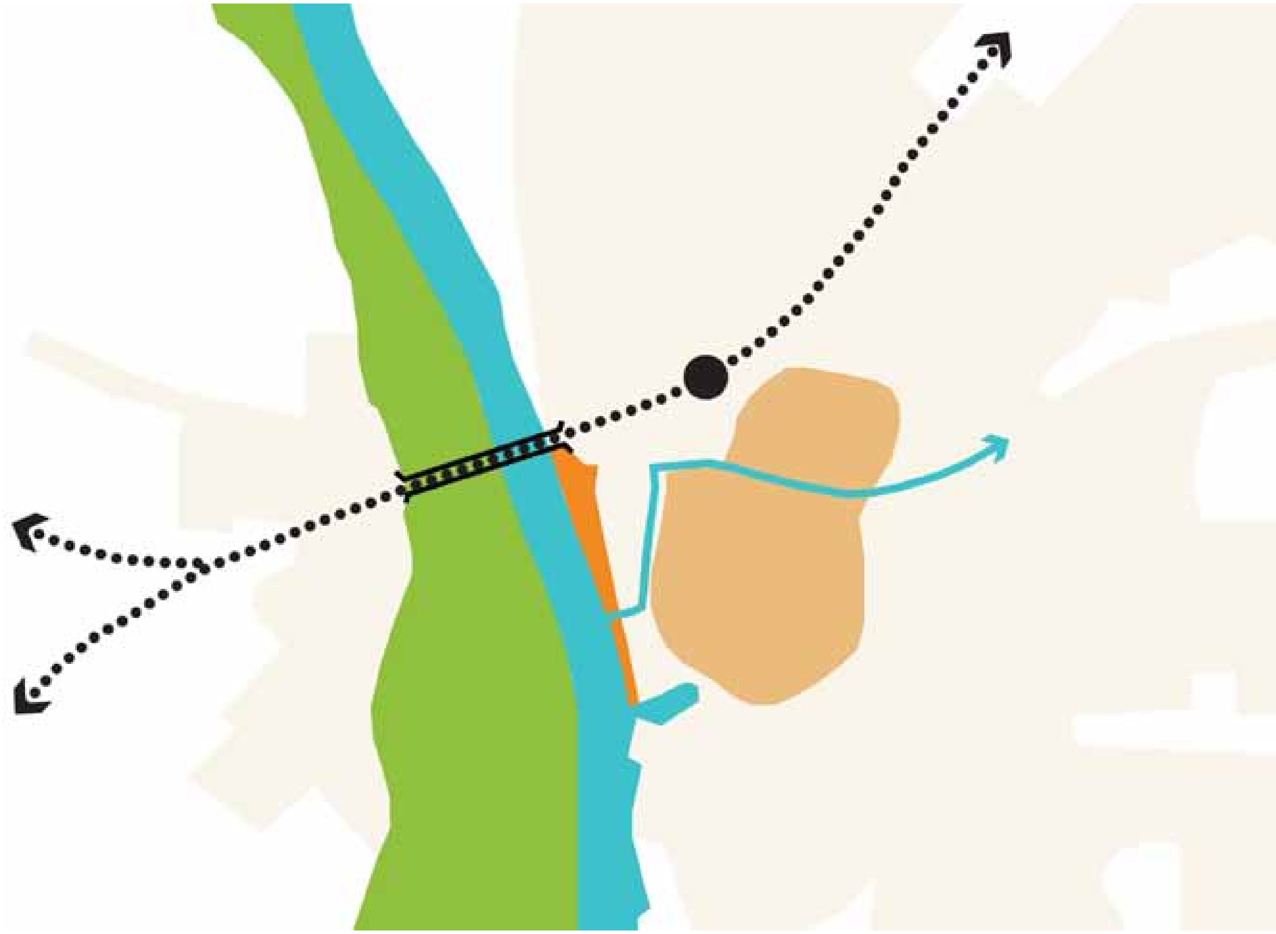
Fig. C.3: Analysis of the city
(Map made by author)

Riverfront
City center
Urbanised area

Fig. C.4: Urban structure.
(Map made by author)

ZUTPHEN

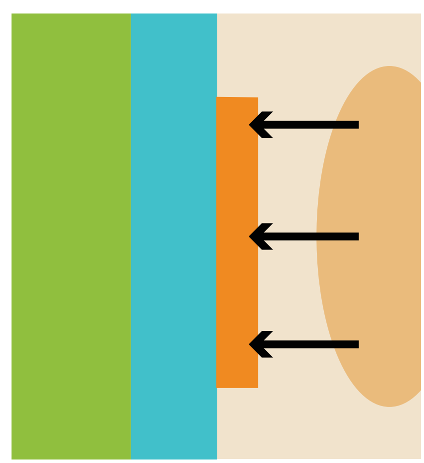
City information
Inhabitants\ 37,500
River\ IJssel
Lenght riverfront\ 580 m
Location inner-city\ Next to the river, with an in-between area.
Opposite riverbank\ Flood plains and small settlement.



Riverfront

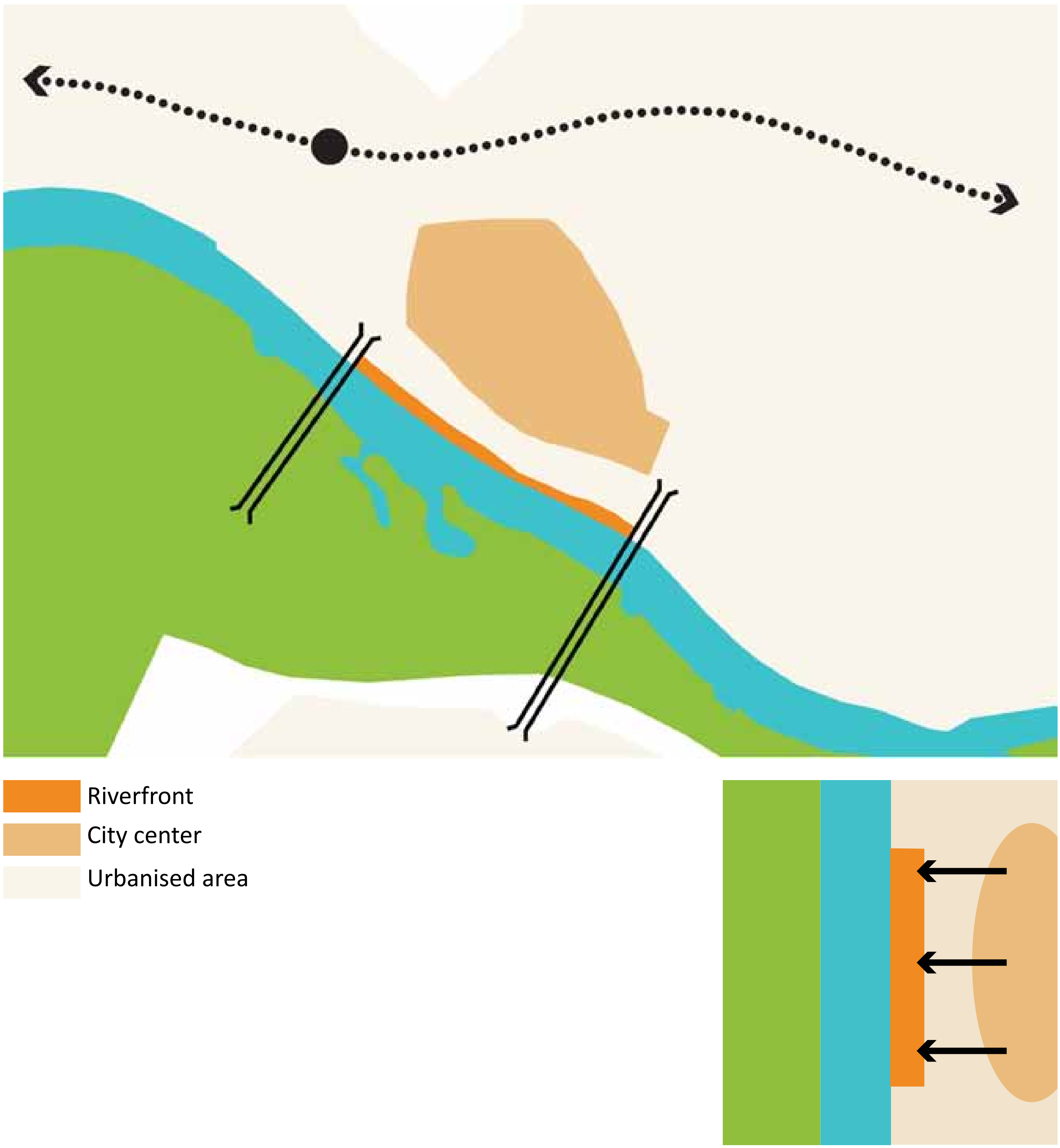
City center

Urbanised area



ARNHEM

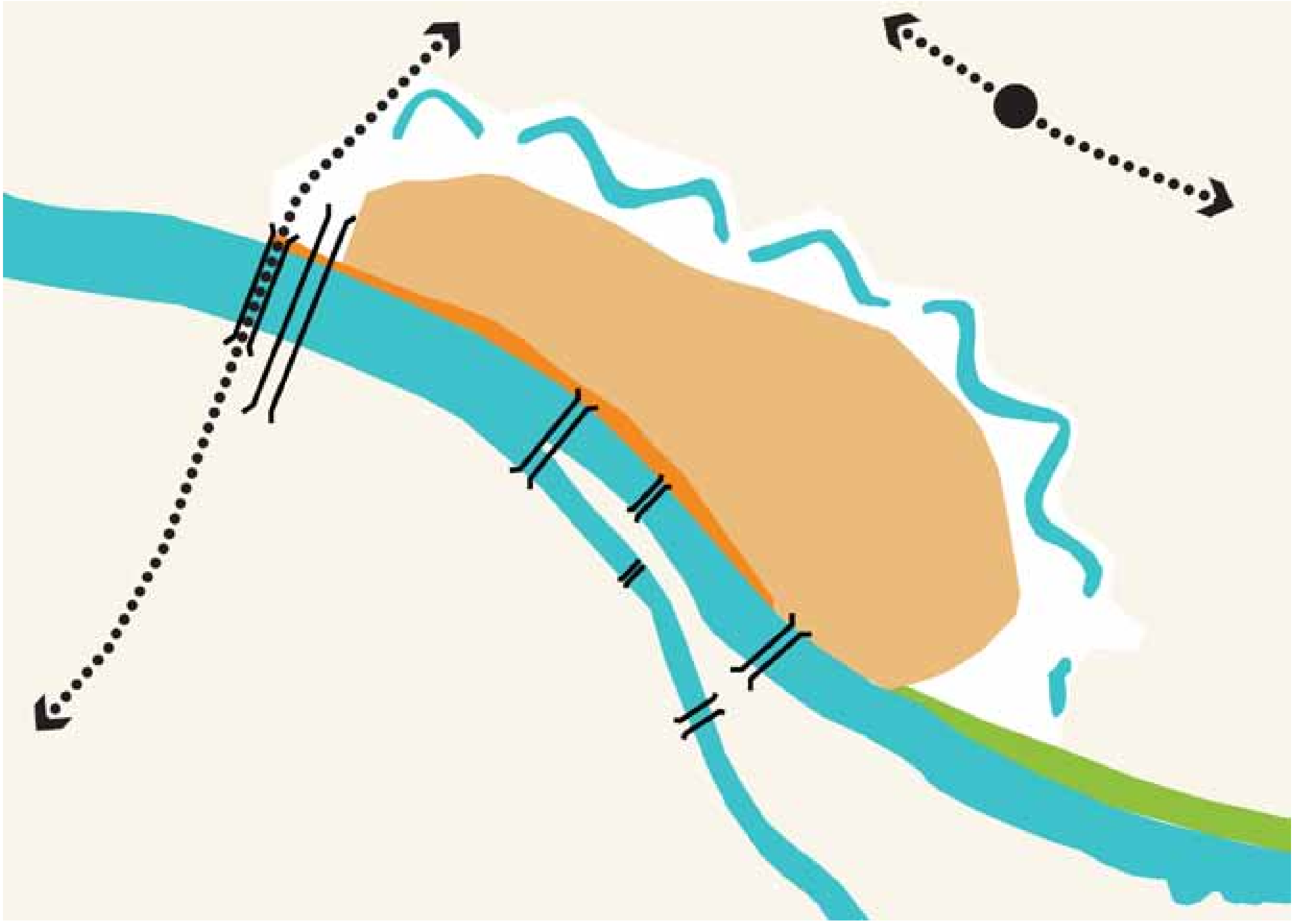
City information
Inhabitants\ 147,000
River\ Nederrijn
Lenght riverfront\ 900 m
Location inner-city\ Not directly connected with the riverfront.
Opposite riverbank\ Floodplains, behind that the city continues.


Riverfront
City center
Urbanised area

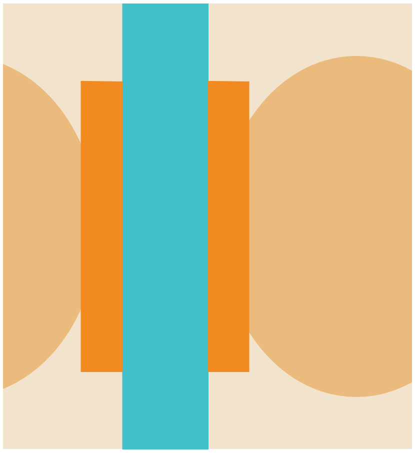
BREMEN

Fig. C.5: source: de.wikipedia.org/wiki/Bremen

City information
Inhabitants\ 550,000
River\ Wezer
Lenght riverfront\ 1,300 m
Location inner-city\ Directly next to the riverfront.
Opposite riverbank\ Completely urbanised.



Riverfront
City center
Urbanised area



CHESTER

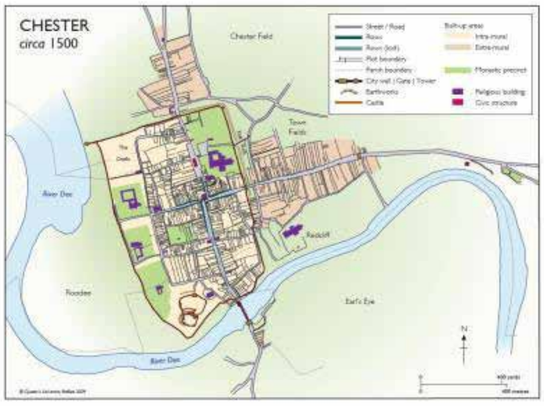
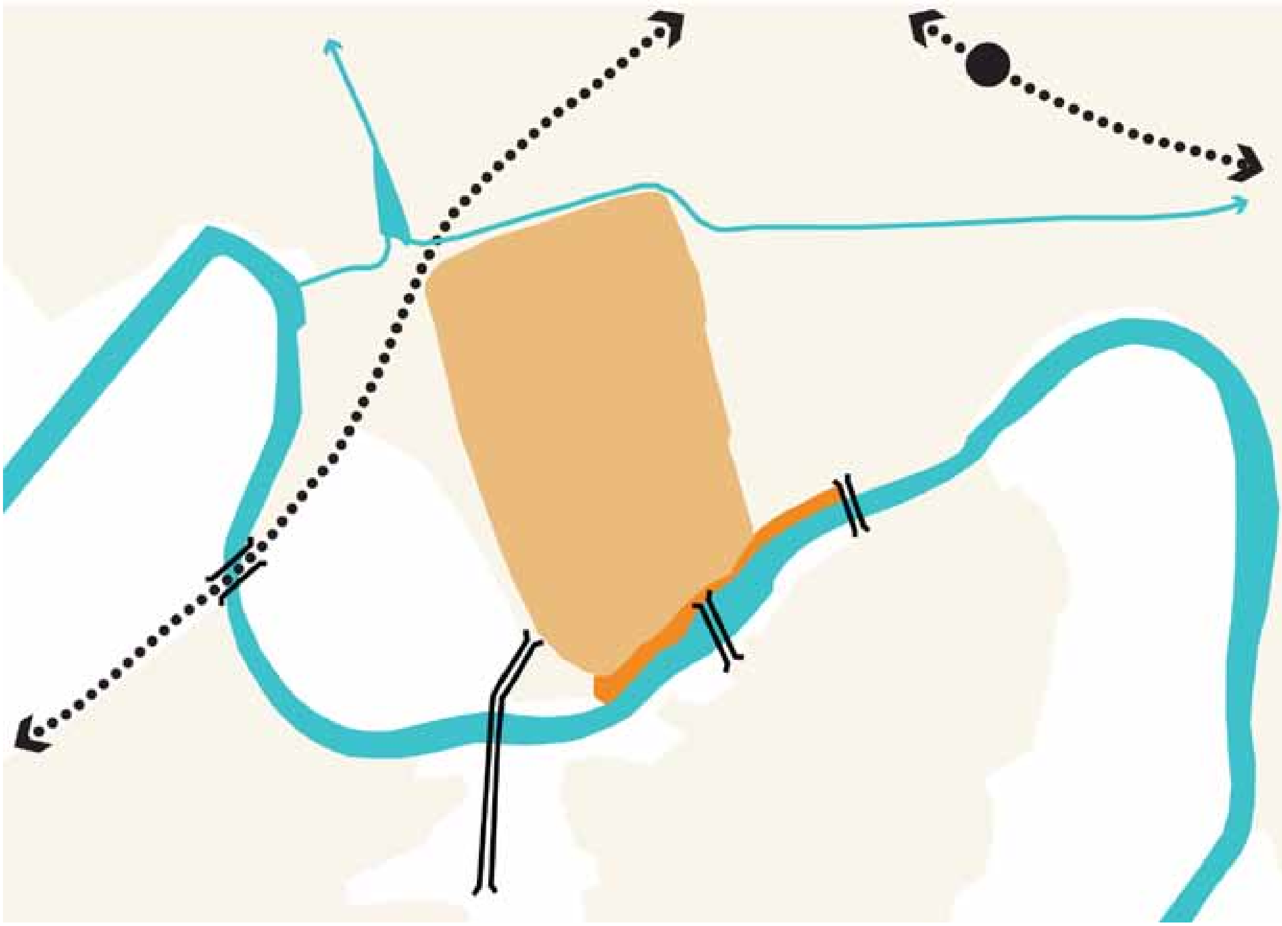


Fig. C.6: source: www.blog.medievalchester.ac.uk

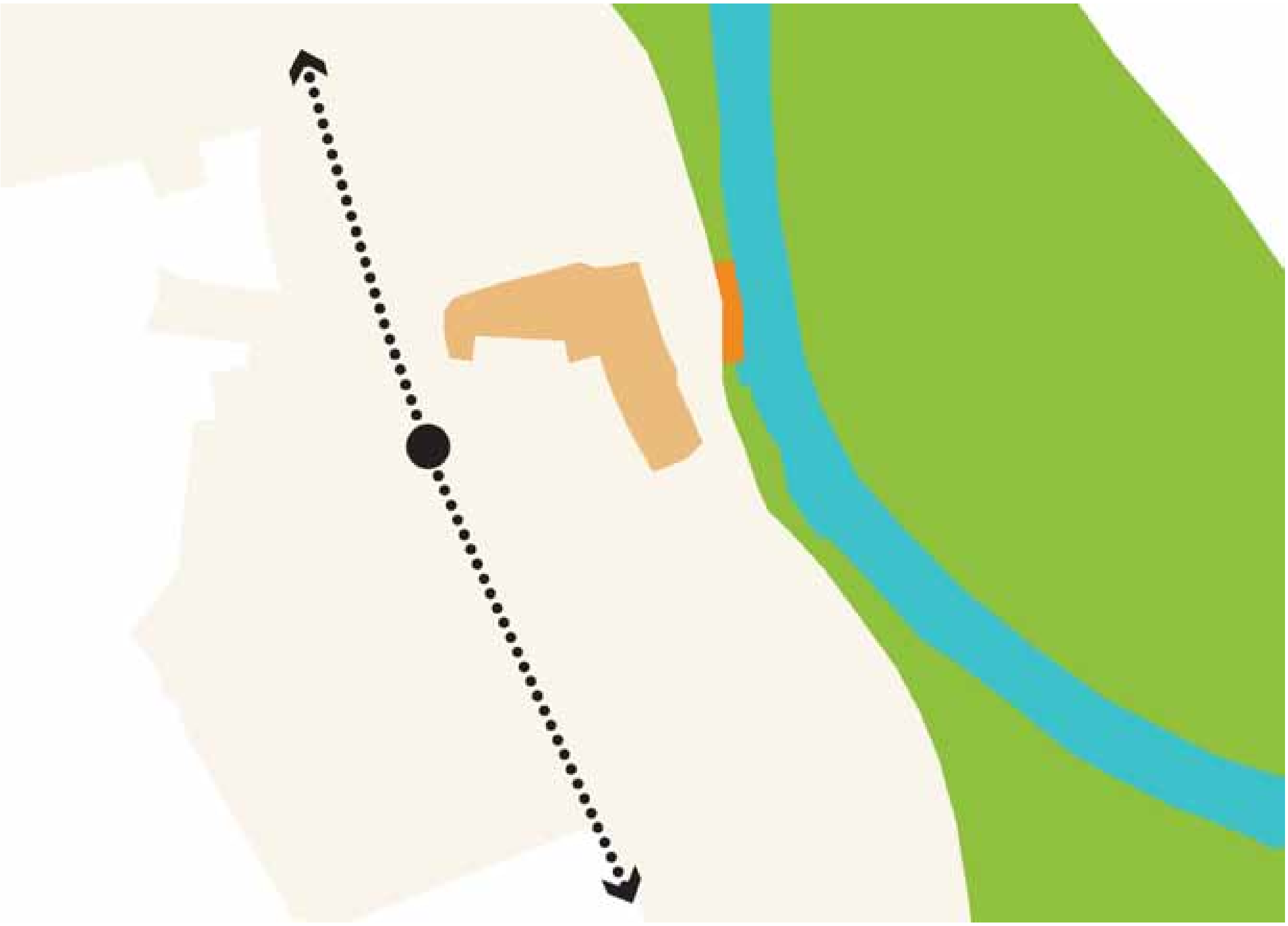
City information
Inhabitants\ 147,000
River\ Nederrijn
Lenght riverfront\ 900 m
Location inner-city\ Not directly connected with the riverfront.
Opposite riverbank\ Floodplains, behind that the city continues.



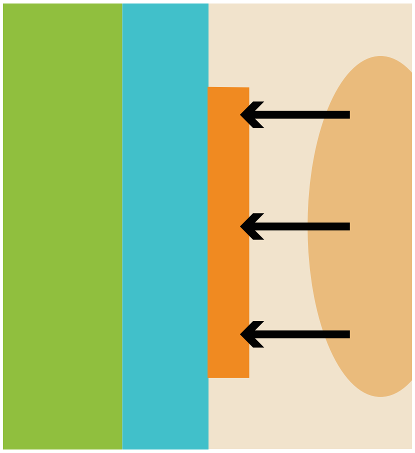
Riverfront
City center
Urbanised area

CUIJK

City information
Inhabitants\ 25,000
River\ Maas
Lenght riverfront\ 300 m
Location inner-city\ Next to the riverfront, with an area in-between.
Opposite riverbank\ Floodplains, no urbanisation.



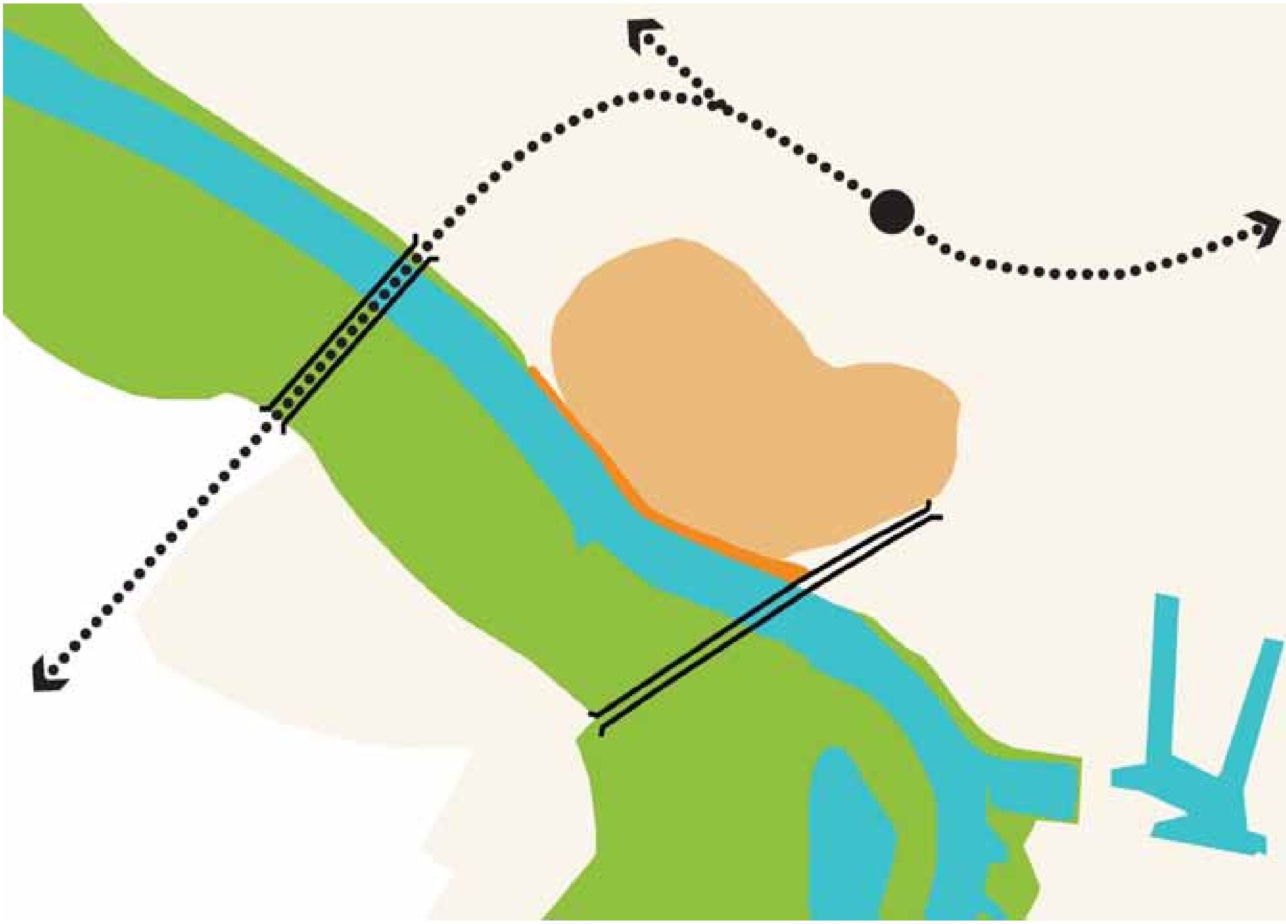
Riverfront
City center
Urbanised area



DEVENTER

City information

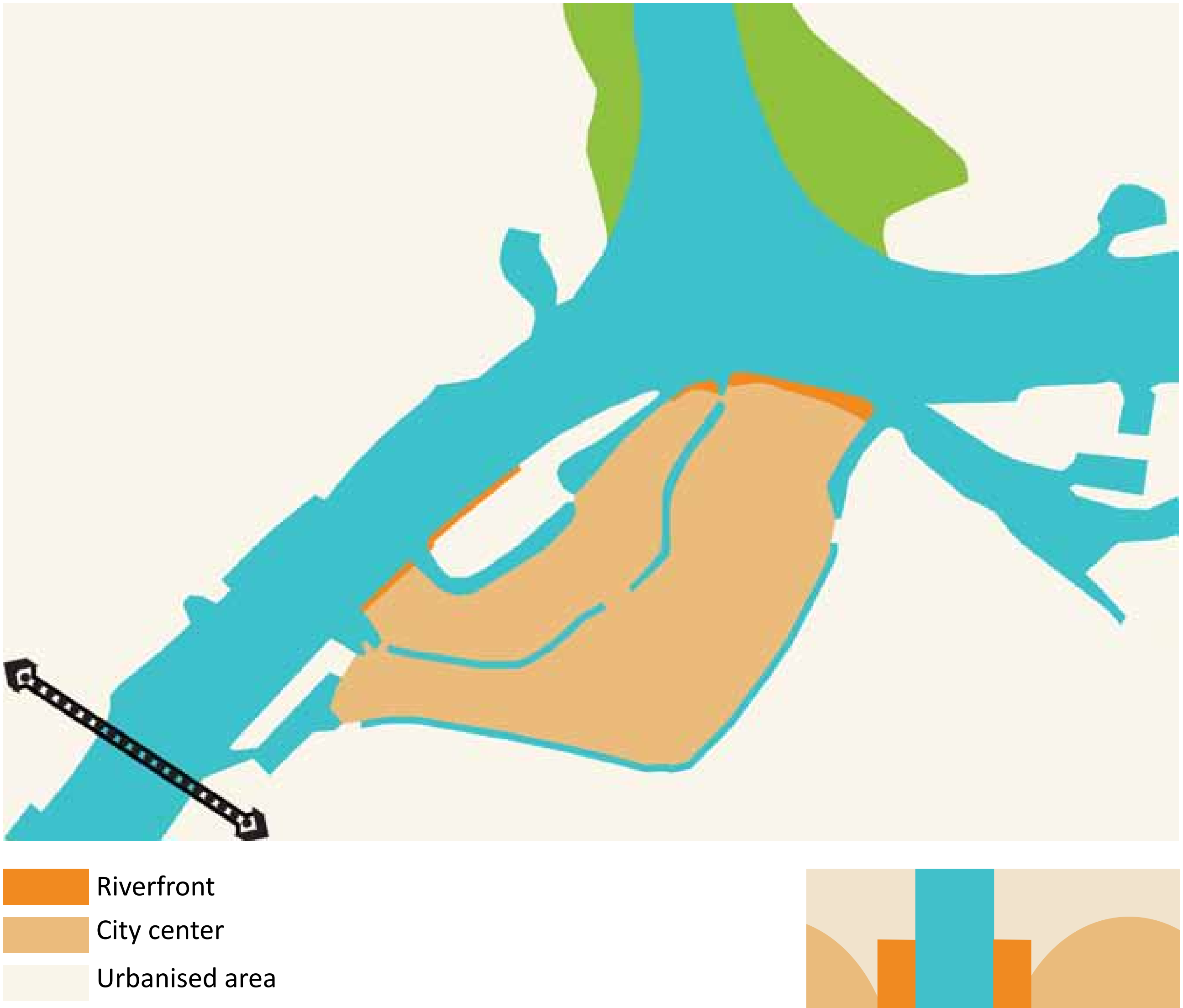
Inhabitants\ 98,000
River\ IJssel
Lenght riverfront\ 700 m
Location inner-city\ Right next to the riverfront.
Opposite riverbank\ Large floodplains and a small settlement.



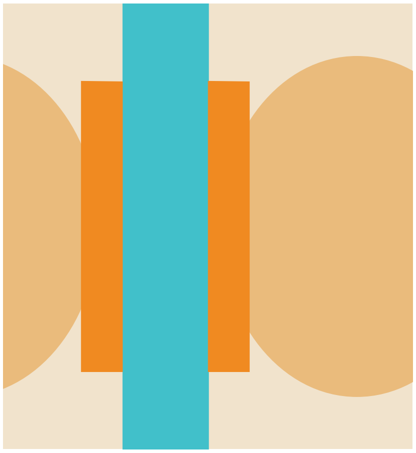
- Riverfront
- City center
- Urbanised area

DORDRECHT

City information
Inhabitants\ 118,000
River\ Merwede, Noord, Oude Maas
Lenght riverfront\ total 800 m
Location inner-city\ At some places right next to the riverfront. On other places there's an in-between area.
Opposite riverbank\ Almost completely urbanised (Zwijndrecht and Papendrecht), inner- and outerdikes.



Riverfront
City center
Urbanised area



EMMERICH

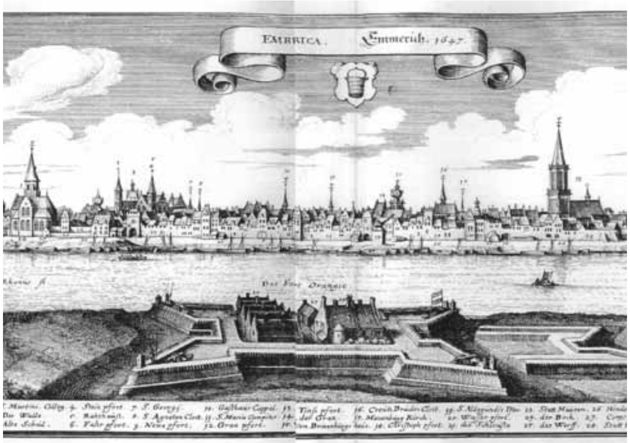
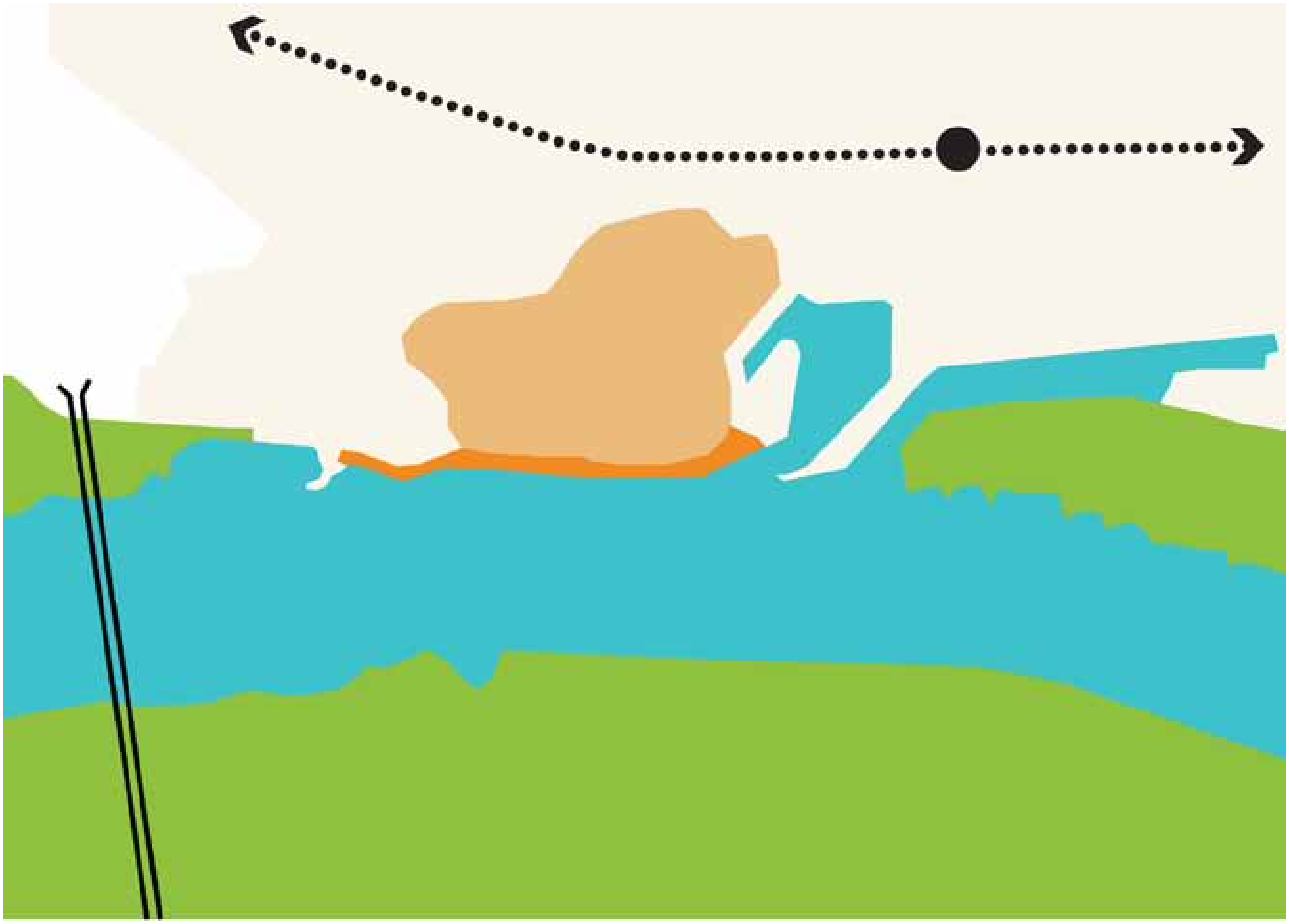


Fig. C.7: source: de.wikipedia.org/wiki/Emmerich_am_Rhein

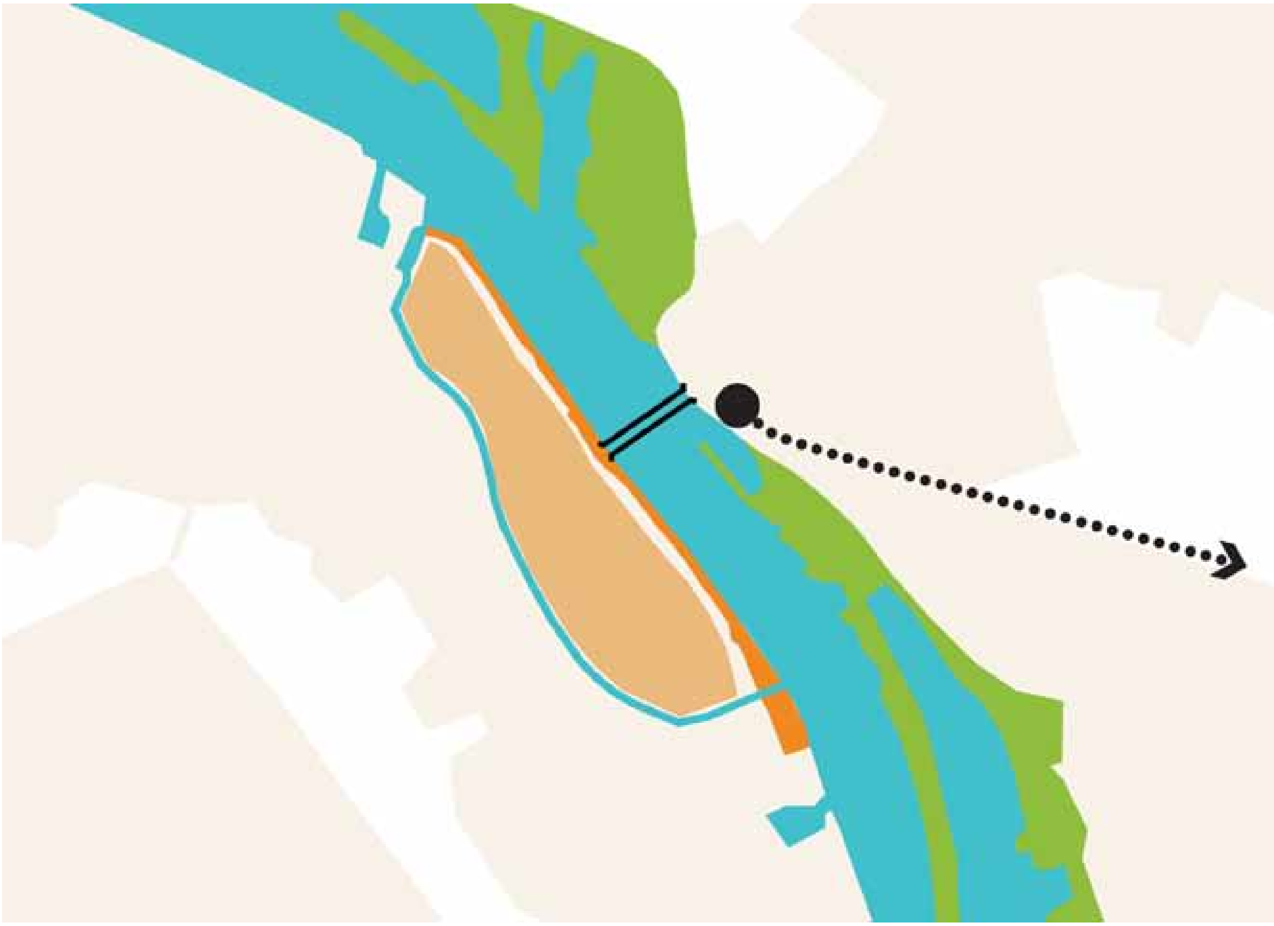
City information
Inhabitants\ 30,000
River\ Rijn
Lenght riverfront\ 900 m
Location inner-city\ Directly next to the river-front.
Opposite riverbank\ Floodplains.



Riverfront
City center
Urbanised area

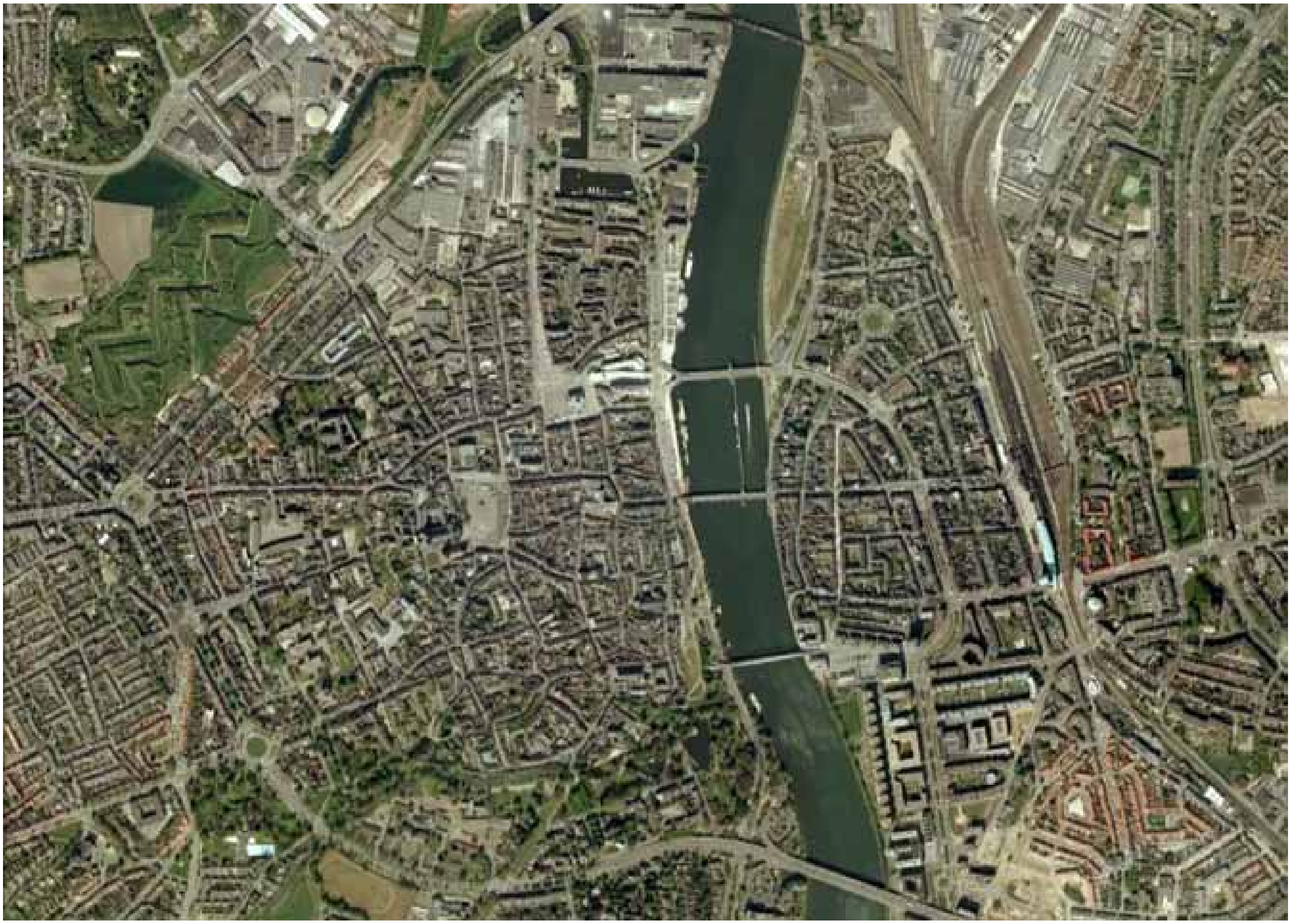
KAMPEN

City information
Inhabitants\ 34,000
River\ IJssel
Lenght riverfront\ 1,300 m
Location inner-city\ Next to the riverfront, with a small in-between area.
Opposite riverbank\ City IJsselmuiden, bottleneck where the city touches the river (bridge). North and south of the built environment space for the river.

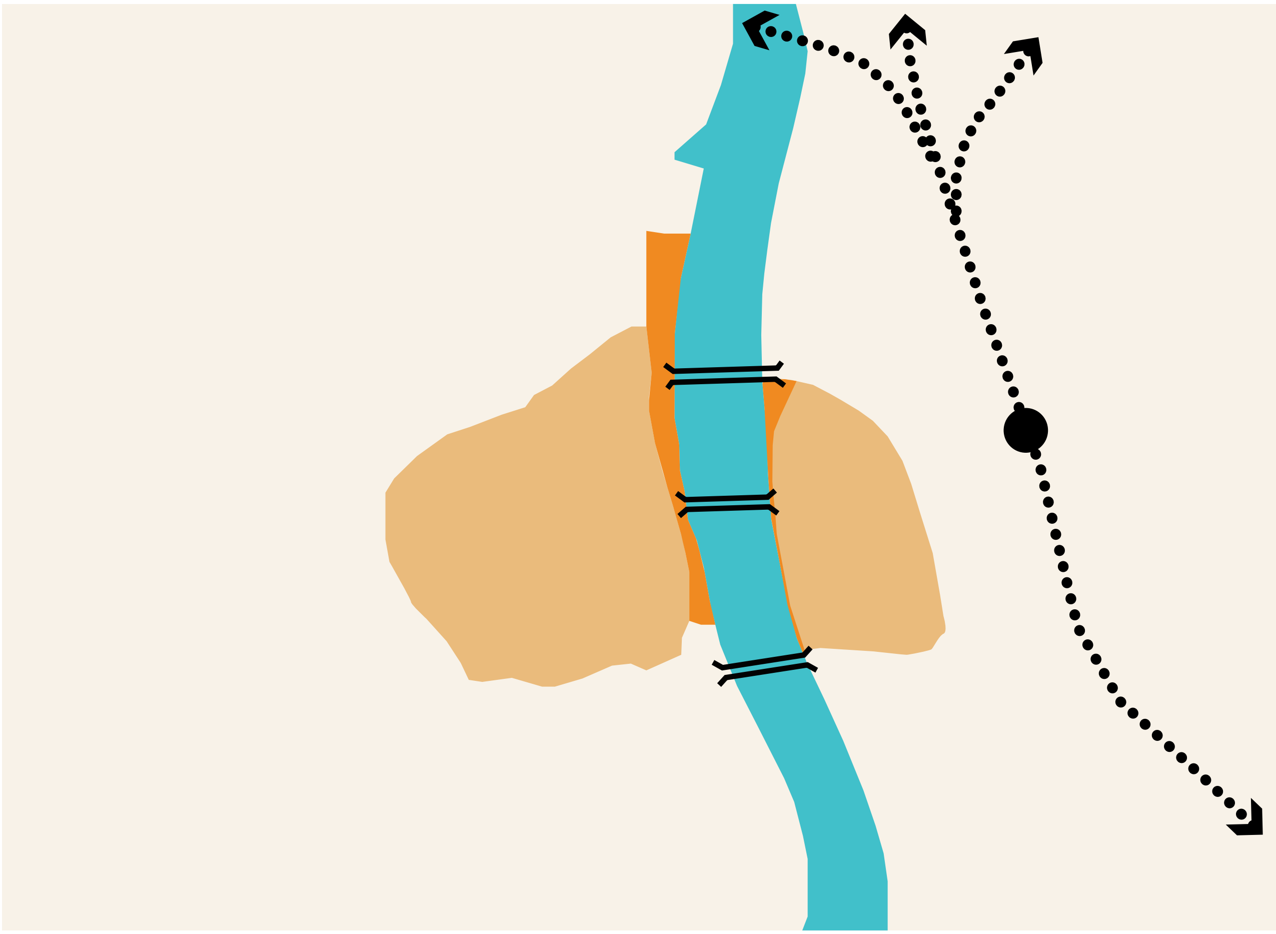


Riverfront
City center
Urbanised area

MAASTRICHT



City information
Inhabitants\ 118,000
River\ Maas
Lenght riverfront\ 850 m and 600 m
Location inner-city\ On both sides, next to the riverfront
Opposite riverbank\ Urban area, also part of the inner-city.

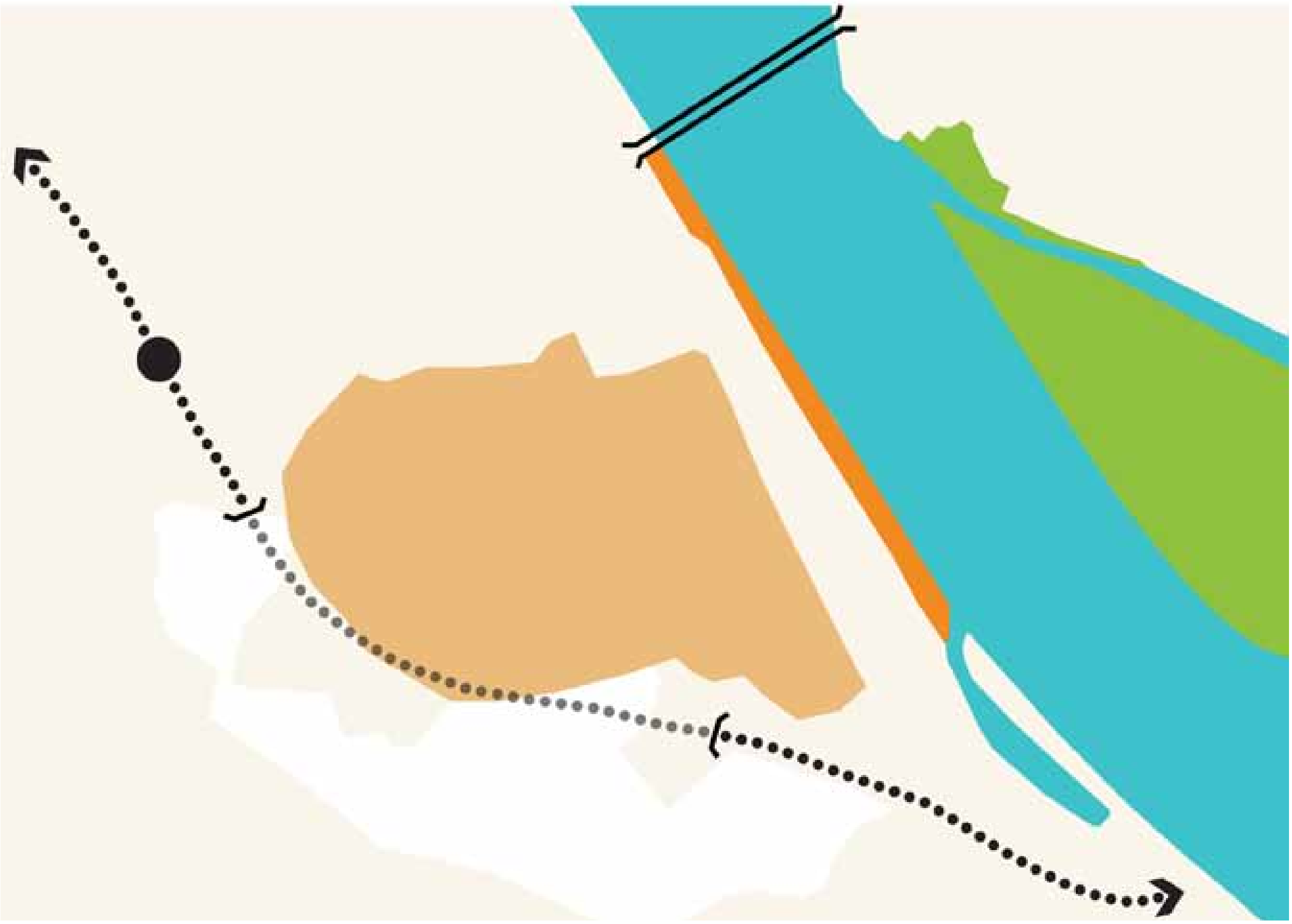


Riverfront
City center
Urbanised area

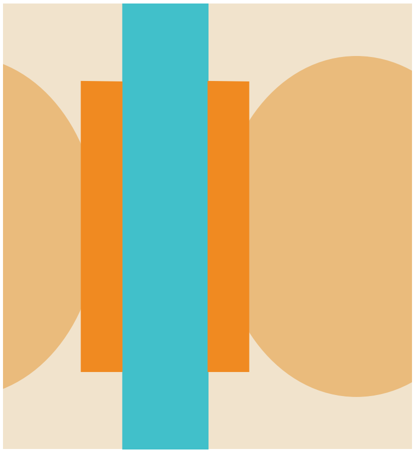
MAINZ

Fig. C.8: source: de.wikipedia.org/wiki/Mainz

City information
Inhabitants\ 198,000
River\ Rijn
Lenght riverfront\ 1,200 m
Location inner-city\ Not directly connected to the riverfront, there's an inbetween area.
Opposite riverbank\ Some green spaces along the river, but mostly urbanised.

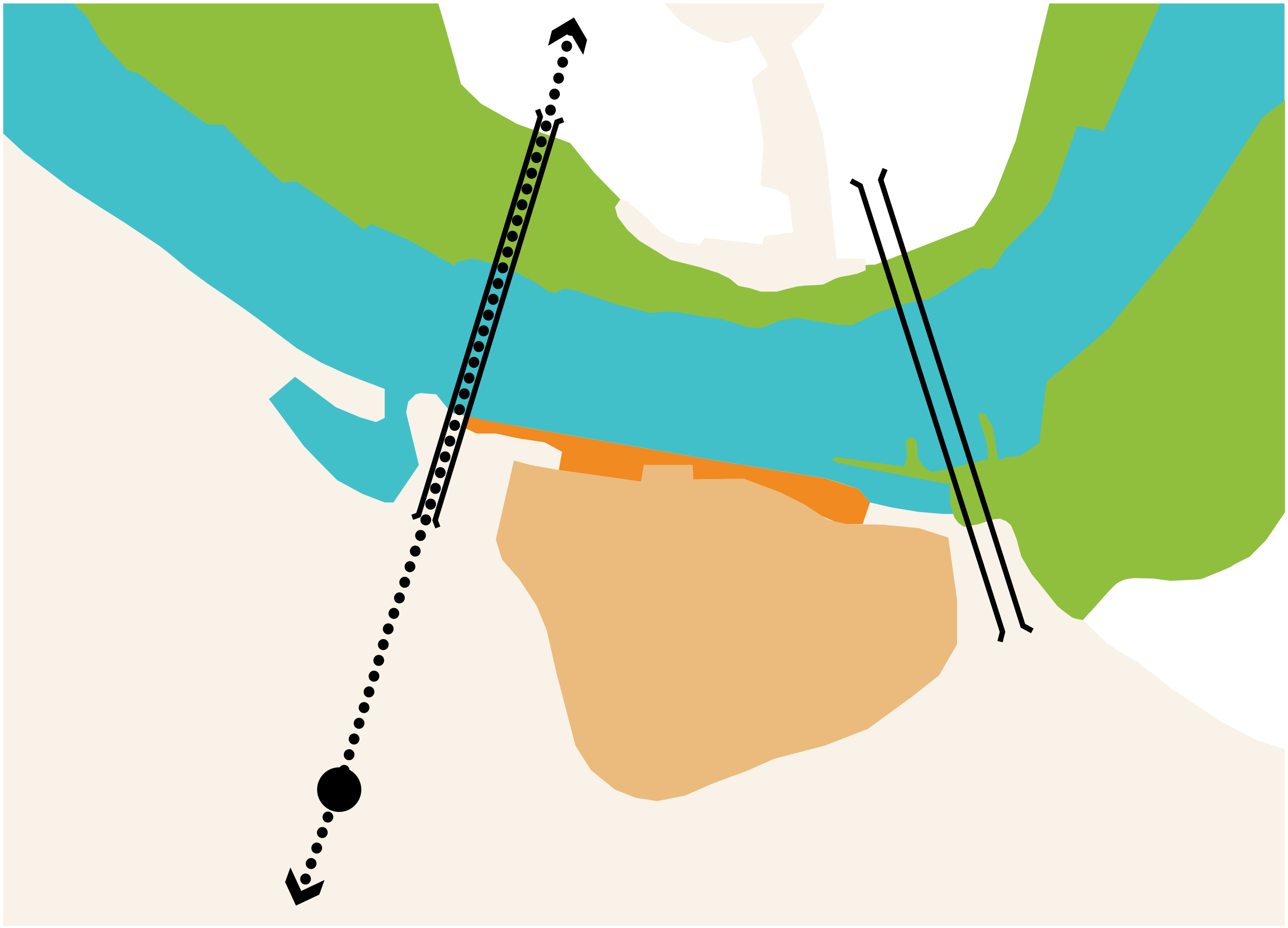


Riverfront
City center
Urbanised area



NIJMEGEN

City information
Inhabitants\ 160,000
River\ Waal
Lenght riverfront\ 900 m
Location inner-city\ Right next to the riverfront.
Opposite riverbank\ Flood plains and a small settlement.



Riverfront
City center
Urbanised area

REES

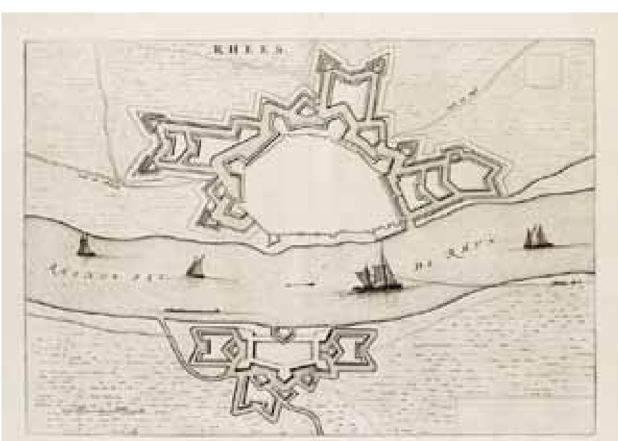
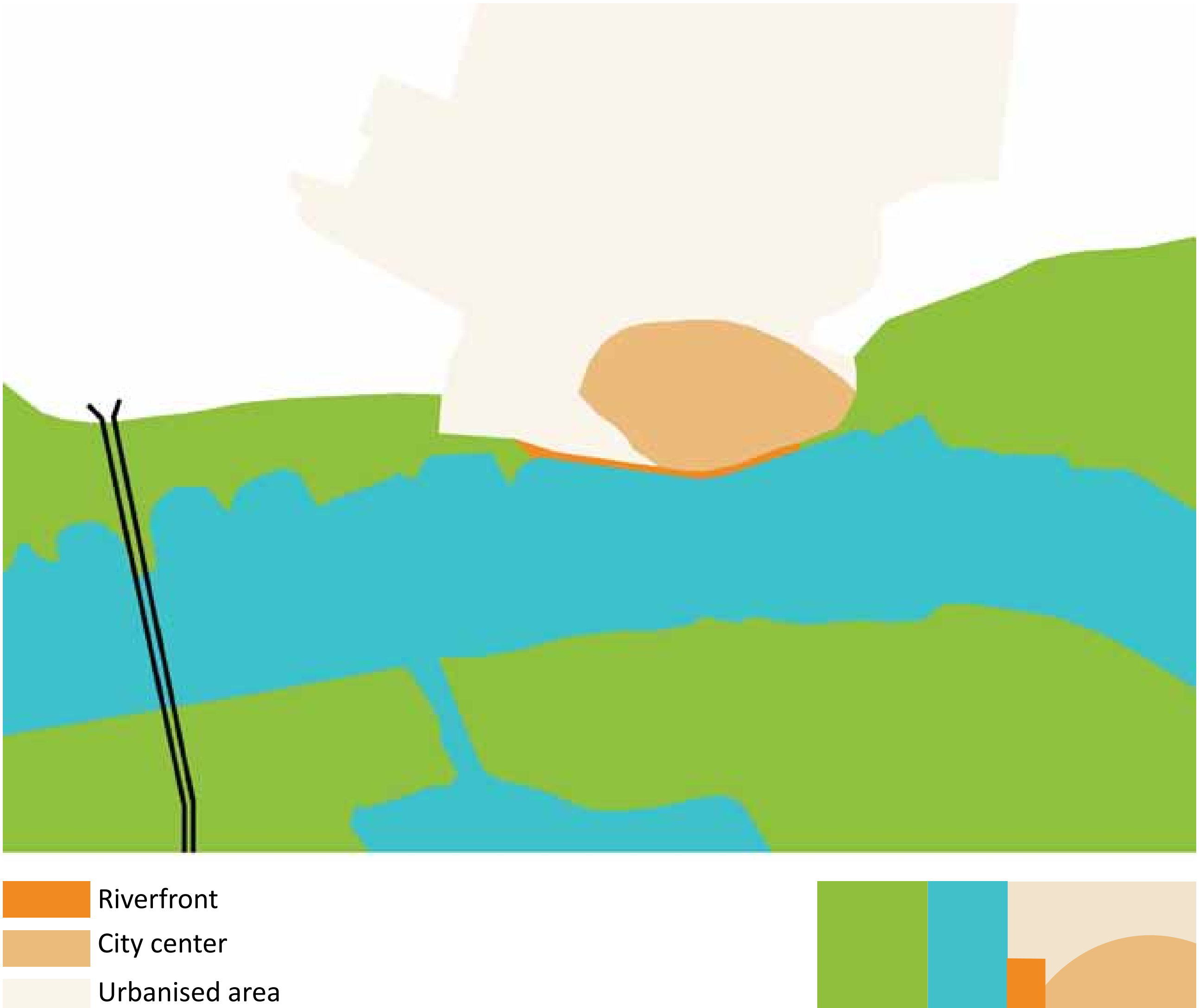


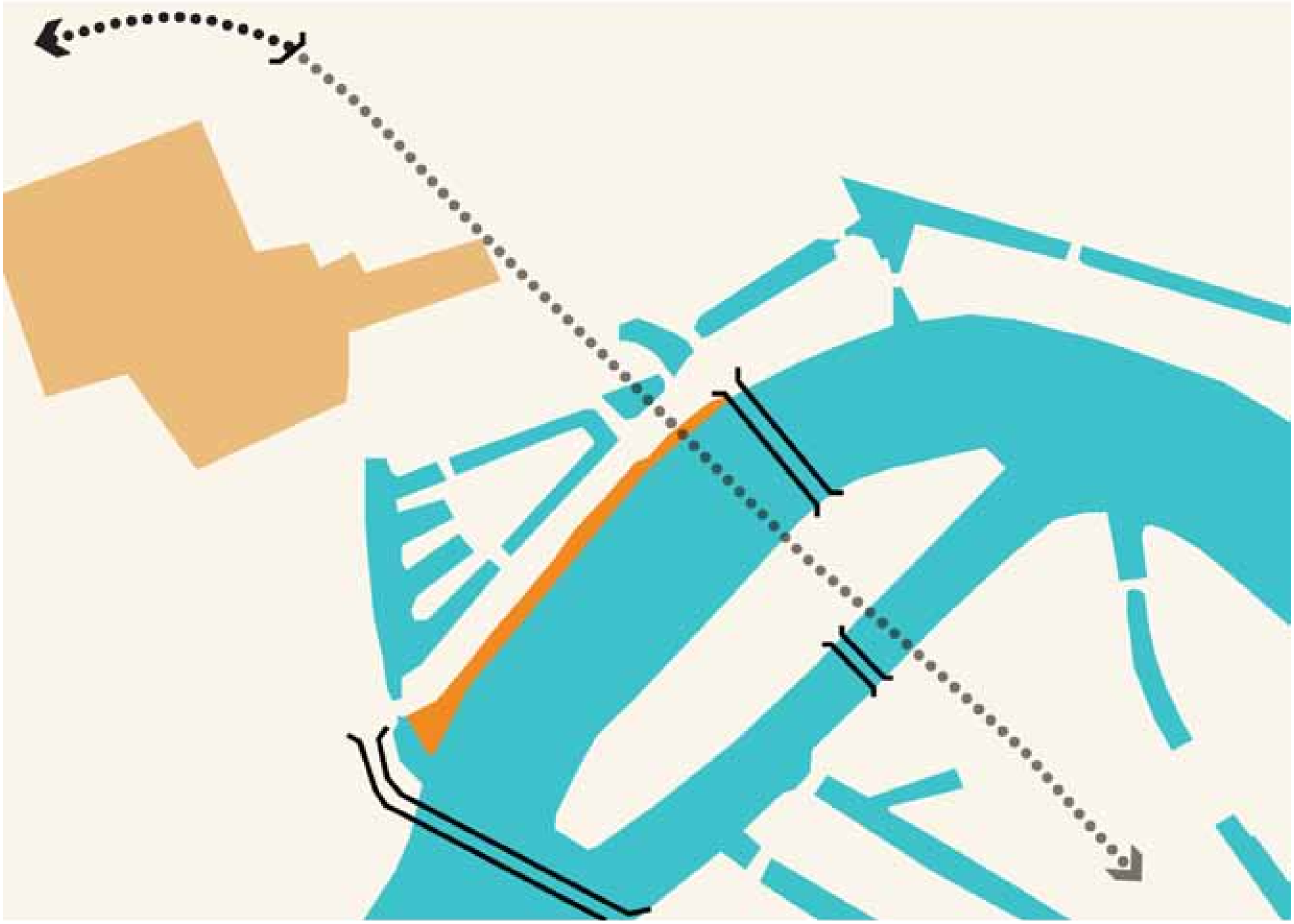
Fig. C.9: source: de.wikipedia.org/wiki/Rees

City information
Inhabitants\ 22,000
River\ Rijn
Lenght riverfront\ 550 m
Location inner-city\ Directly next to the river-front.
Opposite riverbank\ Floodplains

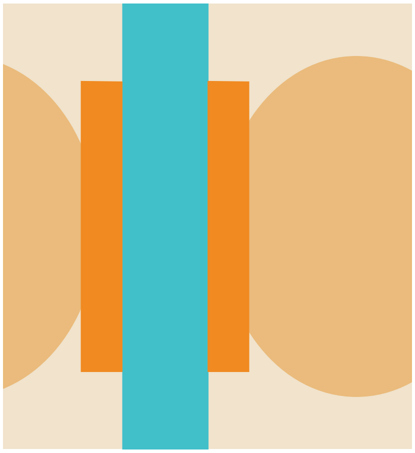

Riverfront
City center
Urbanised area

ROTTERDAM

City information
Inhabitants\ 590,000
River\ Maas
Lenght riverfront\ 1,000 m
Location inner-city\ Far away from the river-front.
Opposite riverbank\ Completely urbanised, also some smaller public riverfronts.



Riverfront
City center
Urbanised area



TIEL

City information

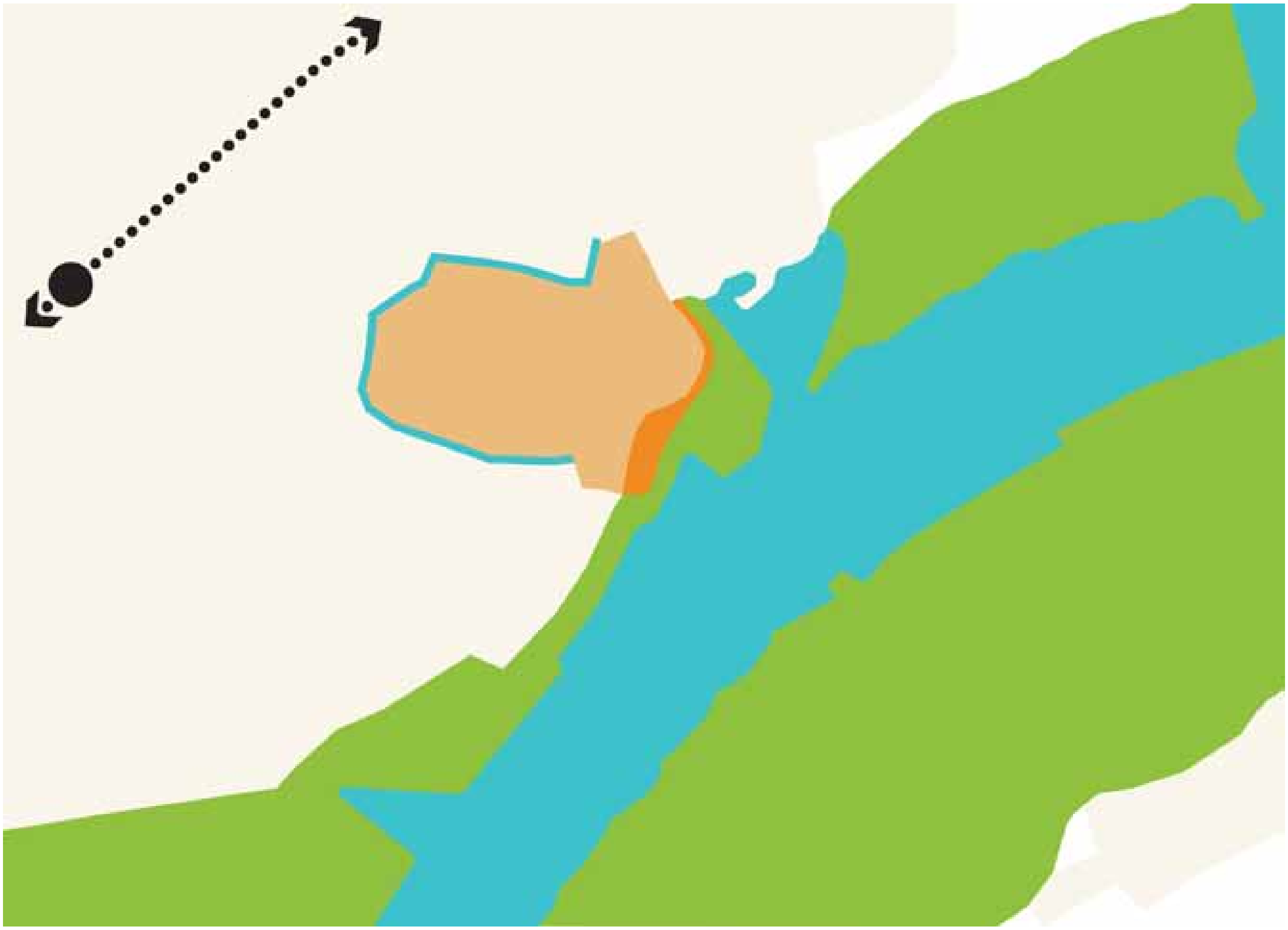
Inhabitants\ 40,000

River\ Waal

Lenght riverfront\ 400 m

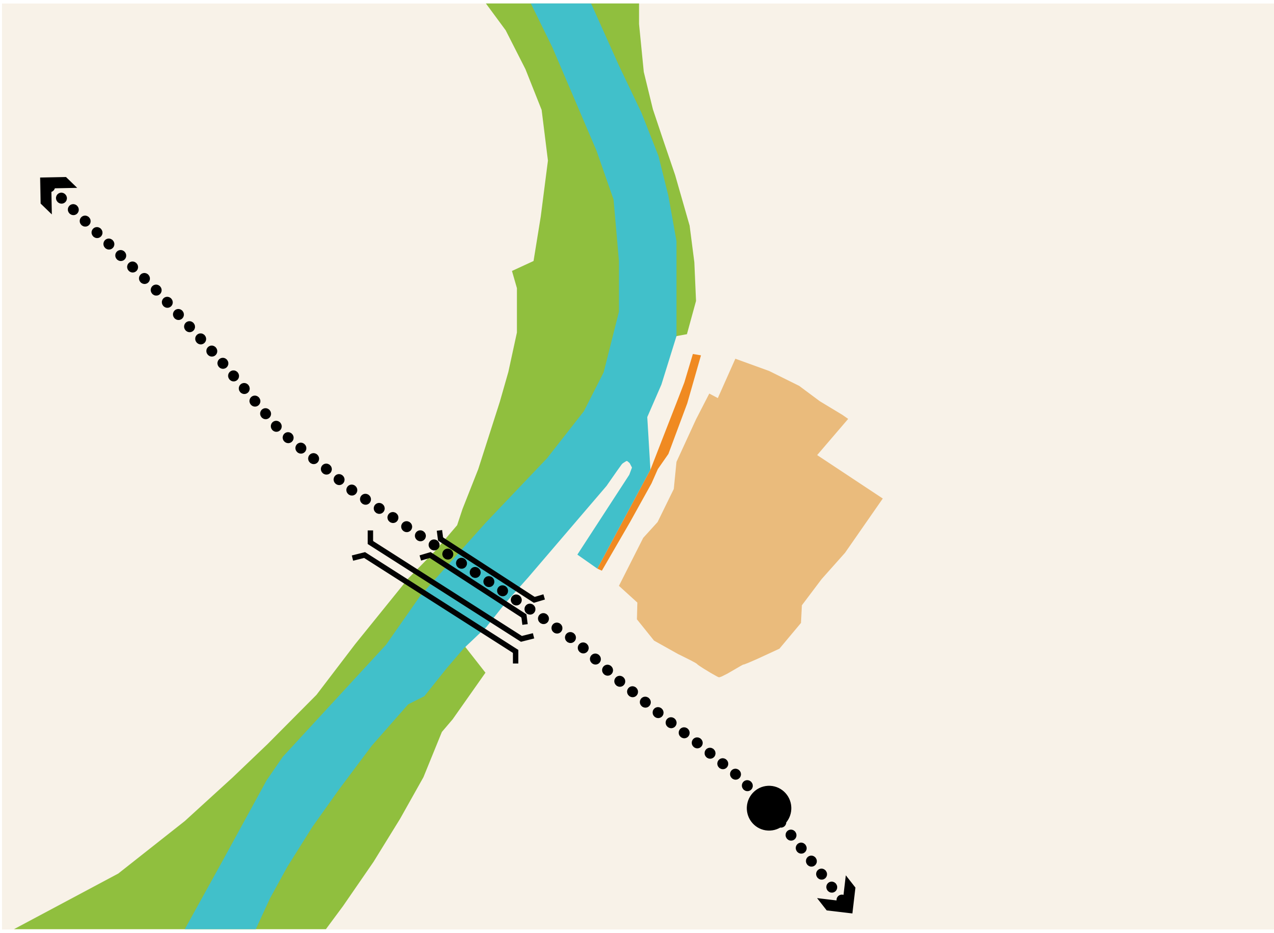
Location inner-city\ Right next to the riverfront, small floodplain between riverfront and river (parking space).

Opposite riverbank\ Floodplains, with small settlement (Wamel) behind it.


Riverfront
City center
Urbanised area

VENLO

City information
Inhabitants\ 35,300
River\ Maas
Lenght riverfront\ 500 m
Location inner-city\ City is close to the riverfront, but there is an in-between area. Between the riverfront and the river is a parking space and a harbor.
Opposite riverbank\ Small floodplains with urbanisation behind it (expansions of Venlo).


Riverfront
City center
Urbanised area

ZALTBOMMEL

City information
Inhabitants\ 12,000
River\ Waal
Lenght riverfront\ 500 m
Location inner-city\ Right next to the riverfront, small floodplain between the riverfront and the river.
Opposite riverbank\ Floodplains, with small settlement (Tuil) behind it.


Riverfront
City center
Urbanised area

APPENDIX D CASE STUDY

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Arnhem	118
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ARNHEM

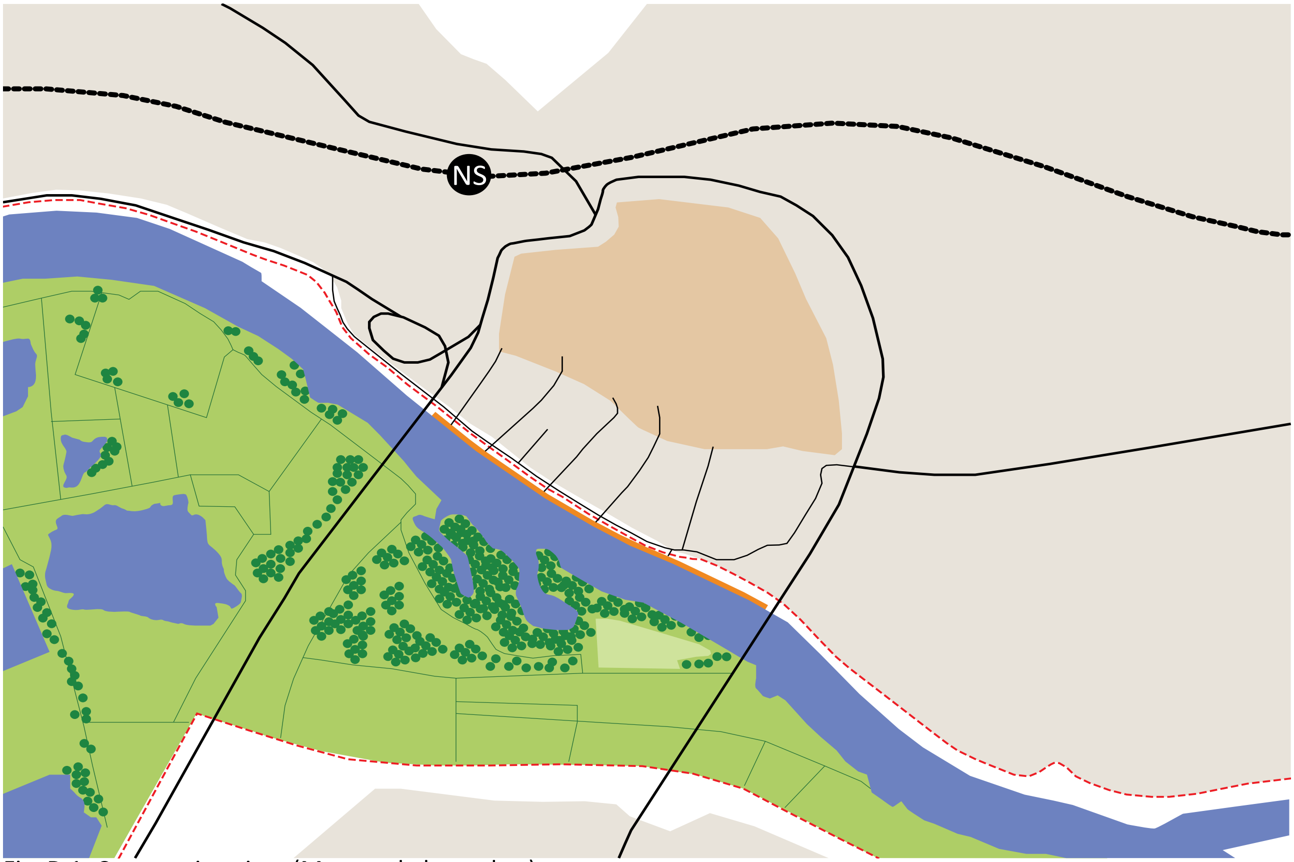


Fig. D.1: Current situation. (Map made by author)


Fig. D.2: Aerial view of Arnhem.
(Source: www.arnhem.nl)


Fig. D.3: The quay of Arnhem.
(Source: Google Earth)

Inhabitants| 147,000

River| Nederrijn

Pedestrian access

- No pedestrian zone to the river.
- Infrastructural barriers between center and river.
- Different building typologies in center and in between area.
- Distance from city center to the river is 240 metres.

Visual link

- Small difference in altitude between city center and riverfront.
- Obstacles block the view.
- Different height levels on the quay.

Activities near the river

- Restaurants and bars.
- Parking.
- Recreation (nature area).
- Space for events.
- Building functions related to the quay.

Connections along riverfront

- Industrial area and residential area.

Pedestrian access

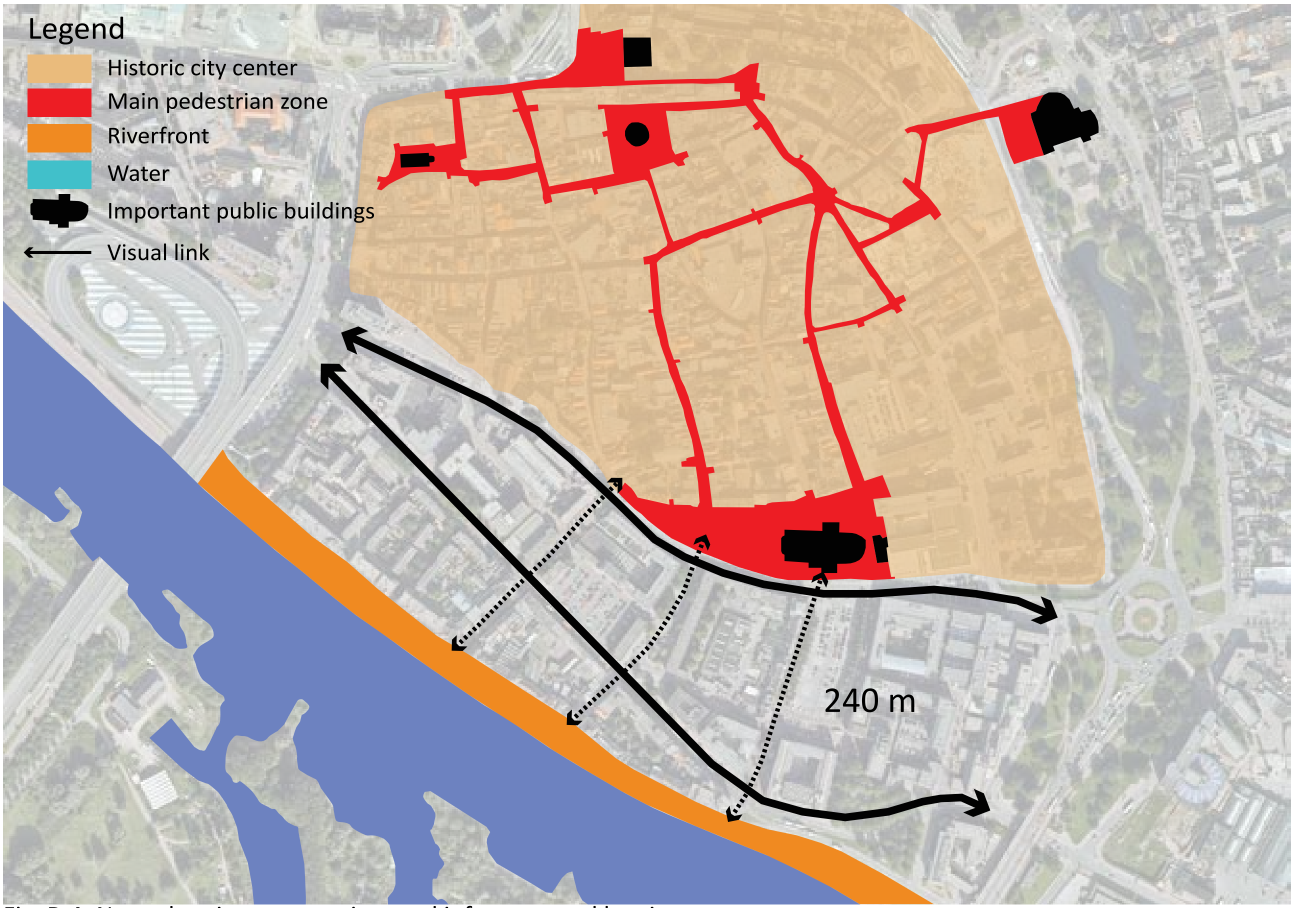


Fig. D.4: No pedestrian zone to river and infrastructural barriers.
(Map made by author)

Fig. D.5: Different building types. (Map made by author)

Visual link

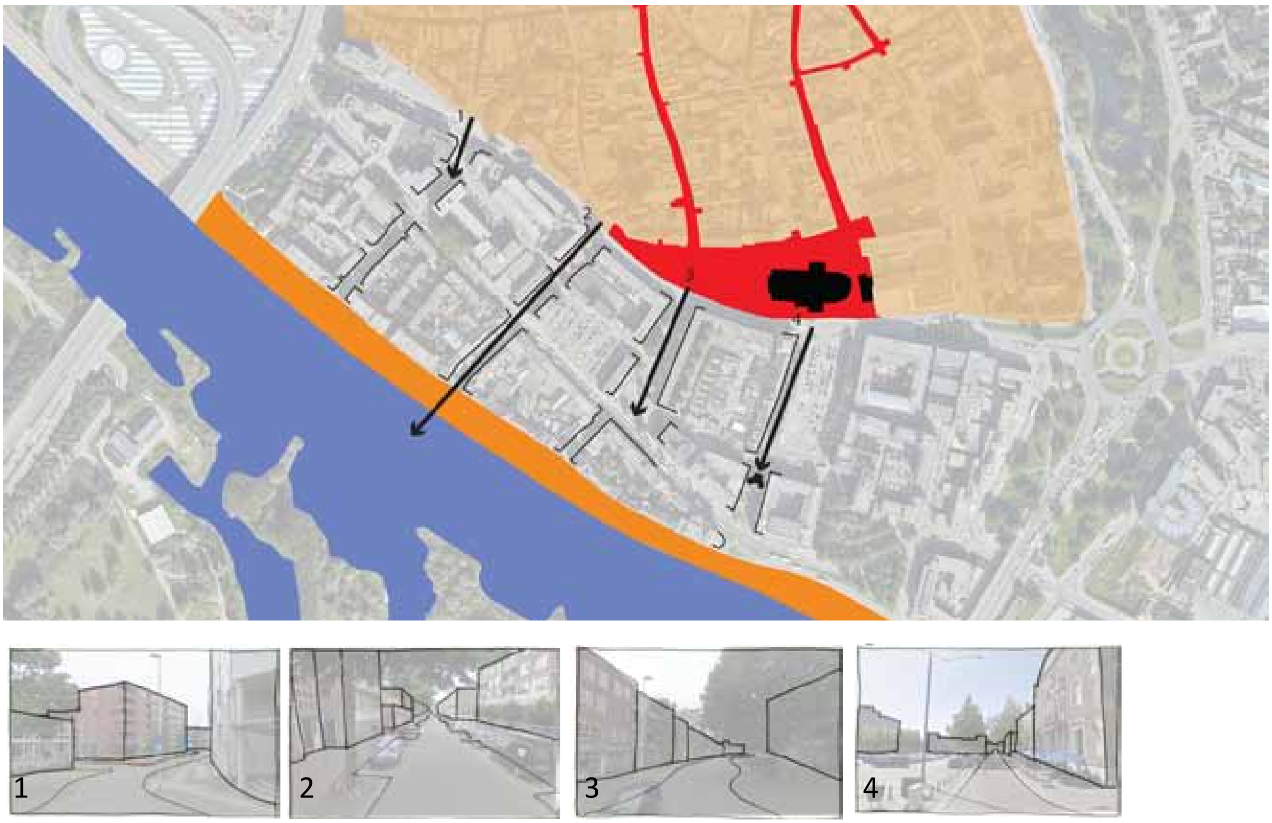


Fig. D.6: Views from the center are blocked by buildings. (Maps made by author)

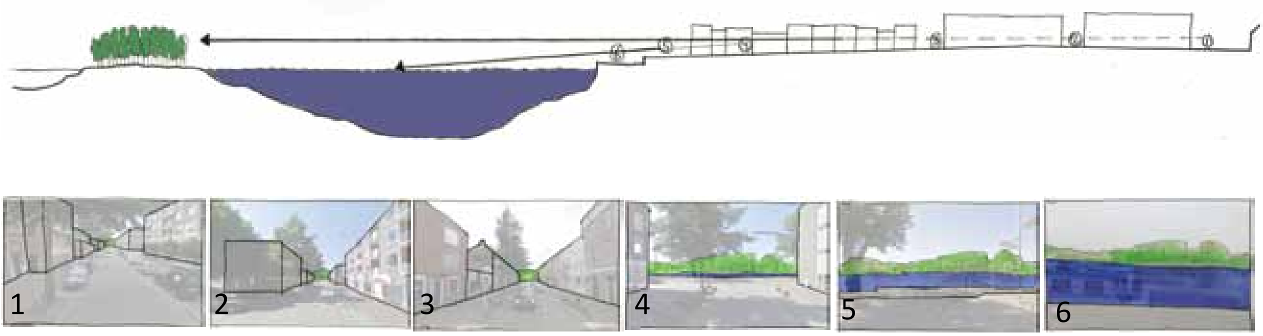


Fig. D.7: Movement from the center to the river, small height difference between center and quay. (Maps made by author)

Visual link and activities

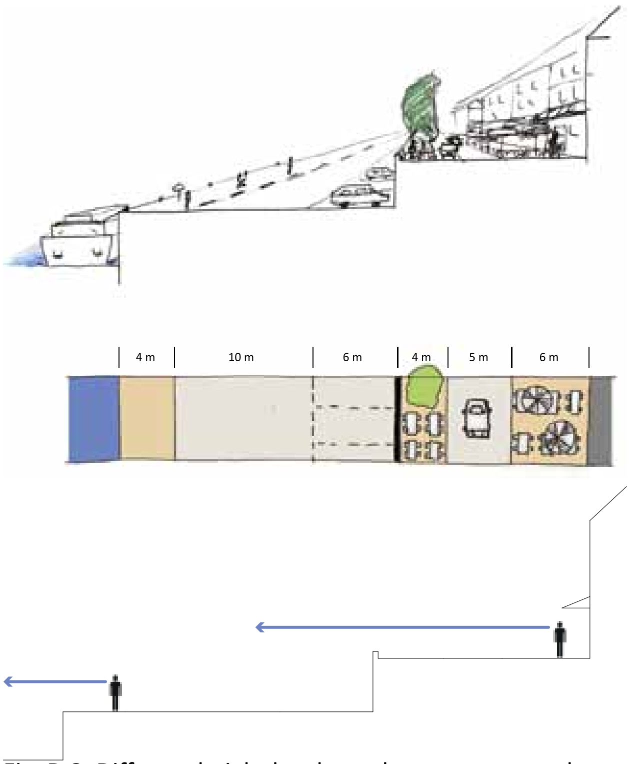
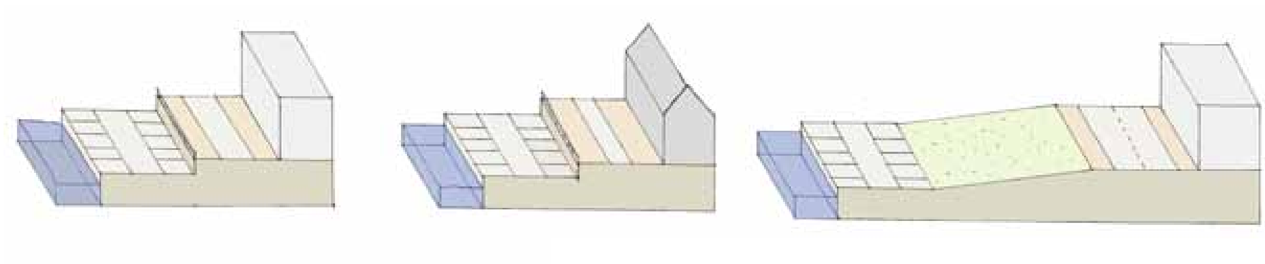


Fig. D.8: Different height levels on the quay create a better sight on the river and make it possible to separate functions. (Maps made by author)

Fig. D.9: Lower level with parking. (Source: Google Earth)

Riverfront zones



Housing from the 60's/70's.
Street with sidewalks.
Parking area.

19th century buildings with
pubs and restaurants.
Small street with terraces.
Parking area.

Offices and public buildings.
Traffic roads.
Green zone.
Parking area.

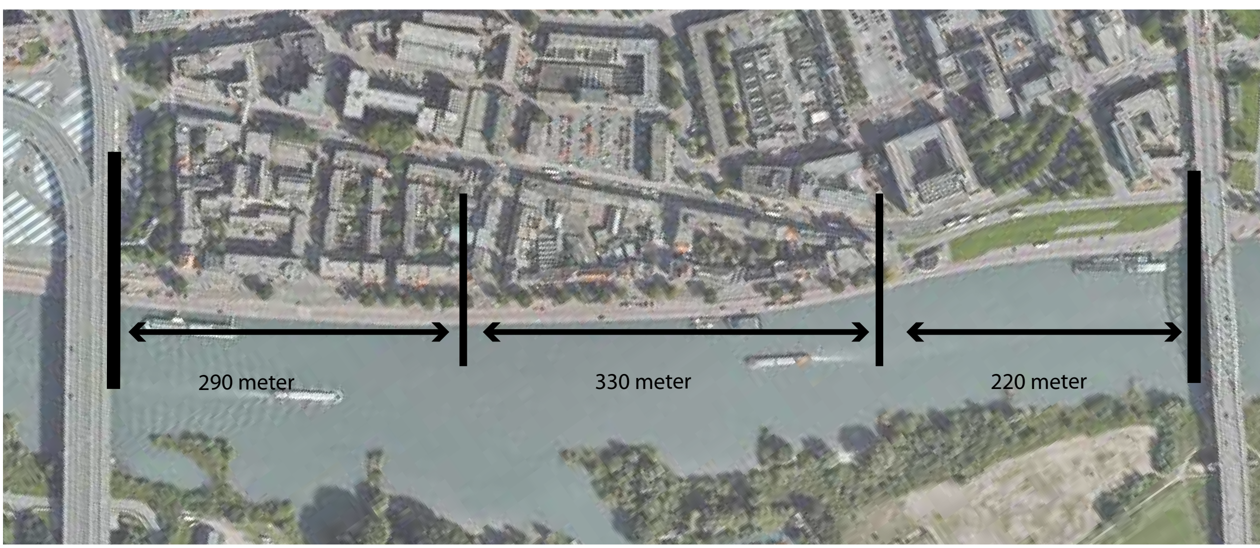


Fig. D.10: Functions on the quay related to the different building types. (Maps made by author)

RIJNBOOG

Fig. D.11: Location of the intervention.

Pedestrian access

- Pedestrian zone to the riverfront.
- Less infrastructural barriers.

Visual link

- River view from city center.

Activities near the river

- Cultural center near the riverfront.

The dark blue rankings show the improvements when the Rijnboog project is finished.

Fig. D.12: Proposed intervention.
(Source: Variantenstudie Havenkwartier, 2009)

Pedestrian access and activities

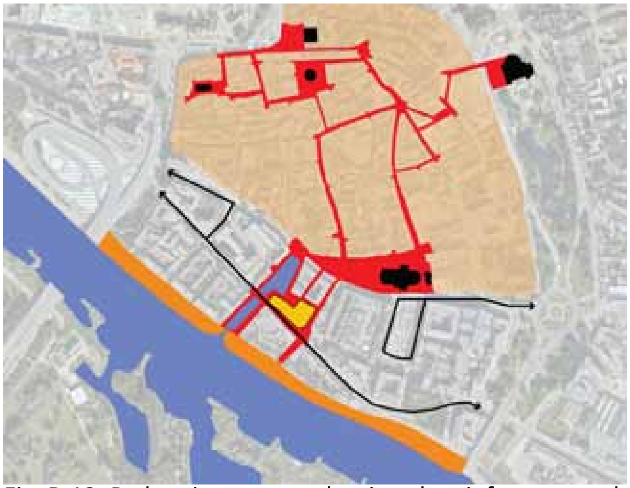


Fig. D.13: Pedestrian zone to the river, less infrastructural barriersand a new function near the riverfront. (Map made by author)

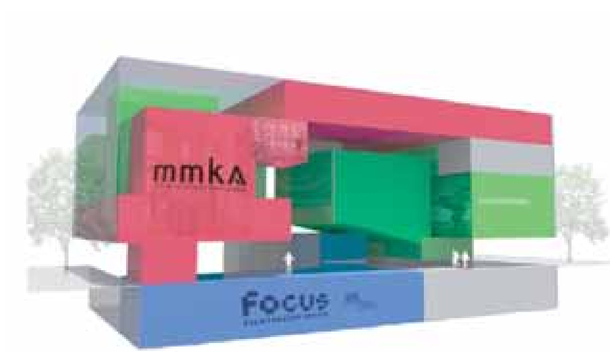


Fig. D.14: New cultural center which attracts people to the river. (Source: Variantenstudie Havenkwartier, 2009)

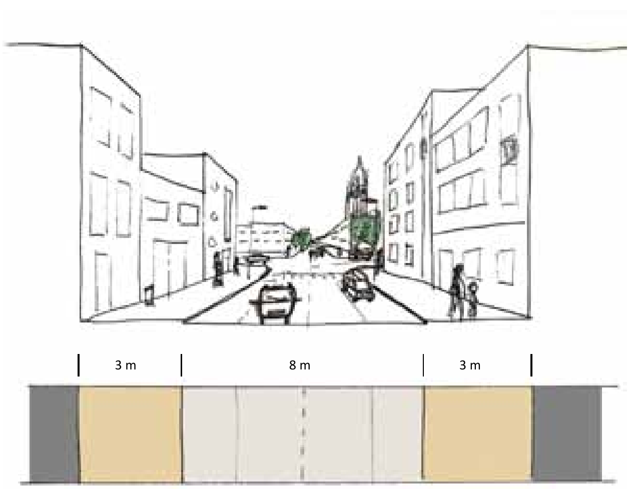


Fig. D.15: Current public street between center and riverfront. (Map made by author)

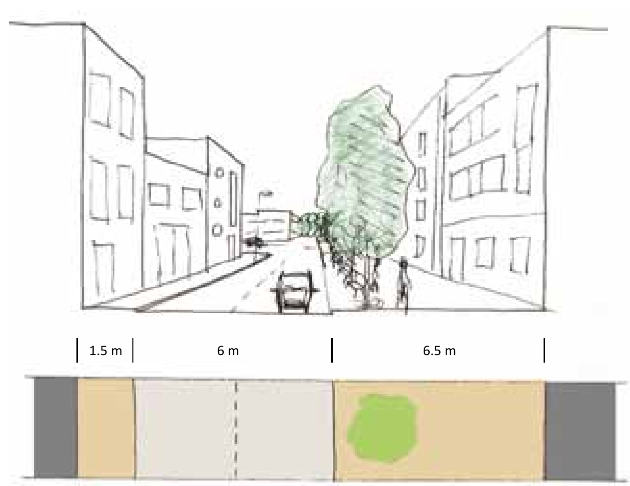


Fig. D.16: New public street between center and riverfront, more space for pedestrians. (Map made by author)

Visual link

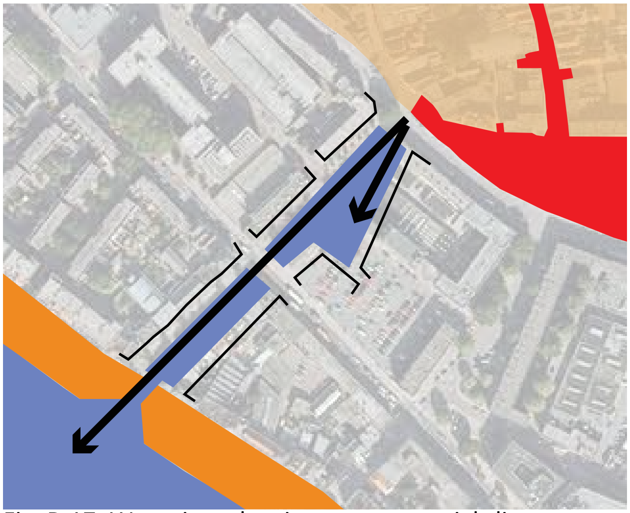


Fig. D.17: Water into the city create new sightlines.
(Map made by author)

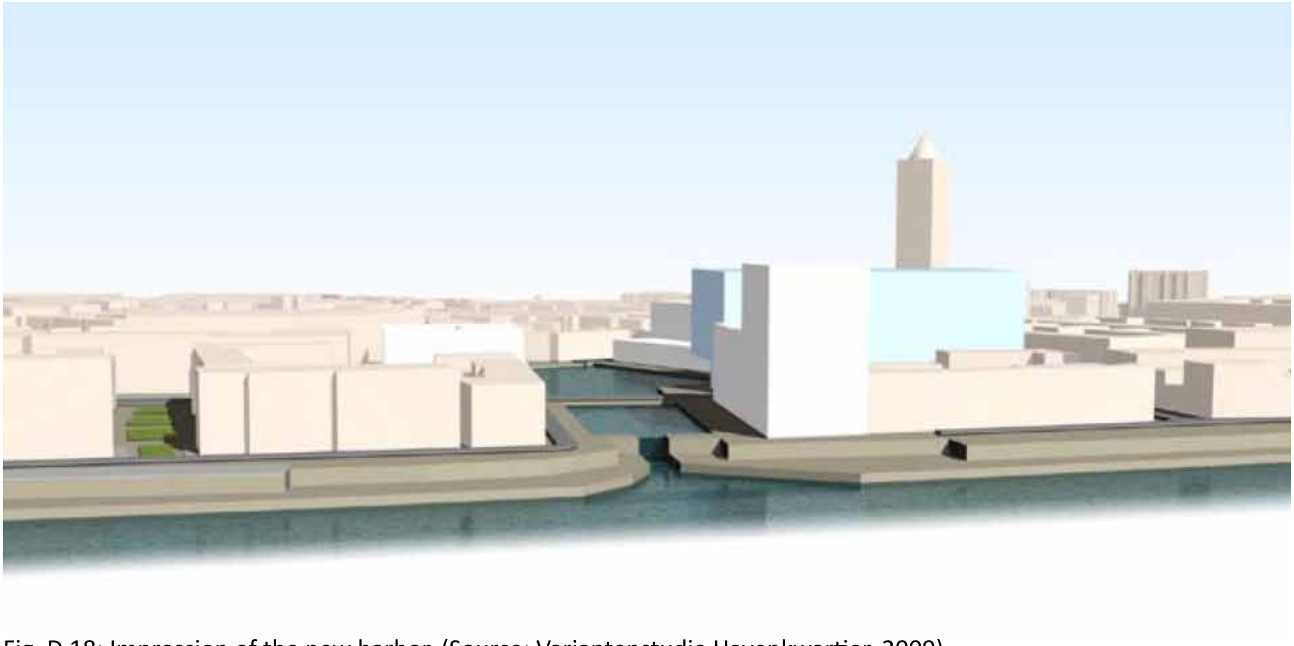


Fig. D.18: Impression of the new harbor. (Source: Variantenstudie Havenkwartier, 2009)

Design principles

Pedestrian access

- Reorganise public space.
- Restructure infrastructure.
- Redesign public quay.

Visual link

- Different height levels on the quay.
- Water into the city.

Activities near the river

- Add function as destination to attract people and change pedestrian flow.
- Zoning along the riverfront.

MAASTRICHT

Fig. D.19: Current situation. (Map made by author)

Fig. D.20: View of Maastricht. (Source: www.maastricht.nl)

Fig. D.21: Aerial view of Maastricht. (Source: Google Earth)

Inhabitants | 118,000

River | Maas

Pedestrian access

- Pedestrian zone embraces the river.
- Almost no infrastructural barriers between center and river.

Visual link

- River(basin) not recognizable in surrounding urban area.

Activities near the river

- Restaurants and bars (terraces)
- Shops (including shopping mall)
- Museums
- Theatre
- Library

Connections along riverfront

- Industrial area, harbor and residential areas.
- Parks on the south end of both riverfronts.
- Multiple bridges over the river.

Pedestrian access and visual link

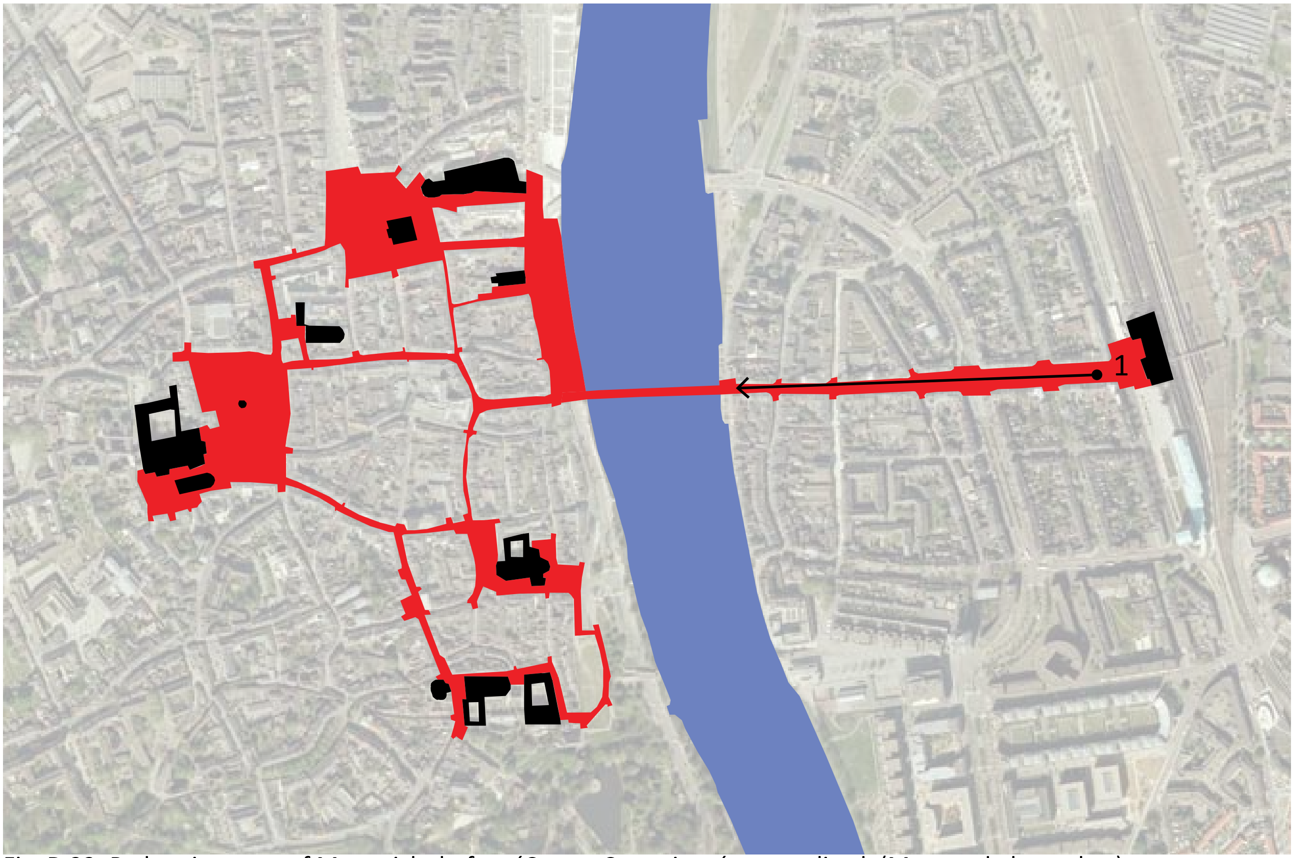


Fig. D.22: Pedestrian zone of Maastricht before ´Centre Ceramique´ was realised. (Map made by author)


Fig. D. 23: View on the river from the station (position 1).
(Map made by author)

Connections and activities

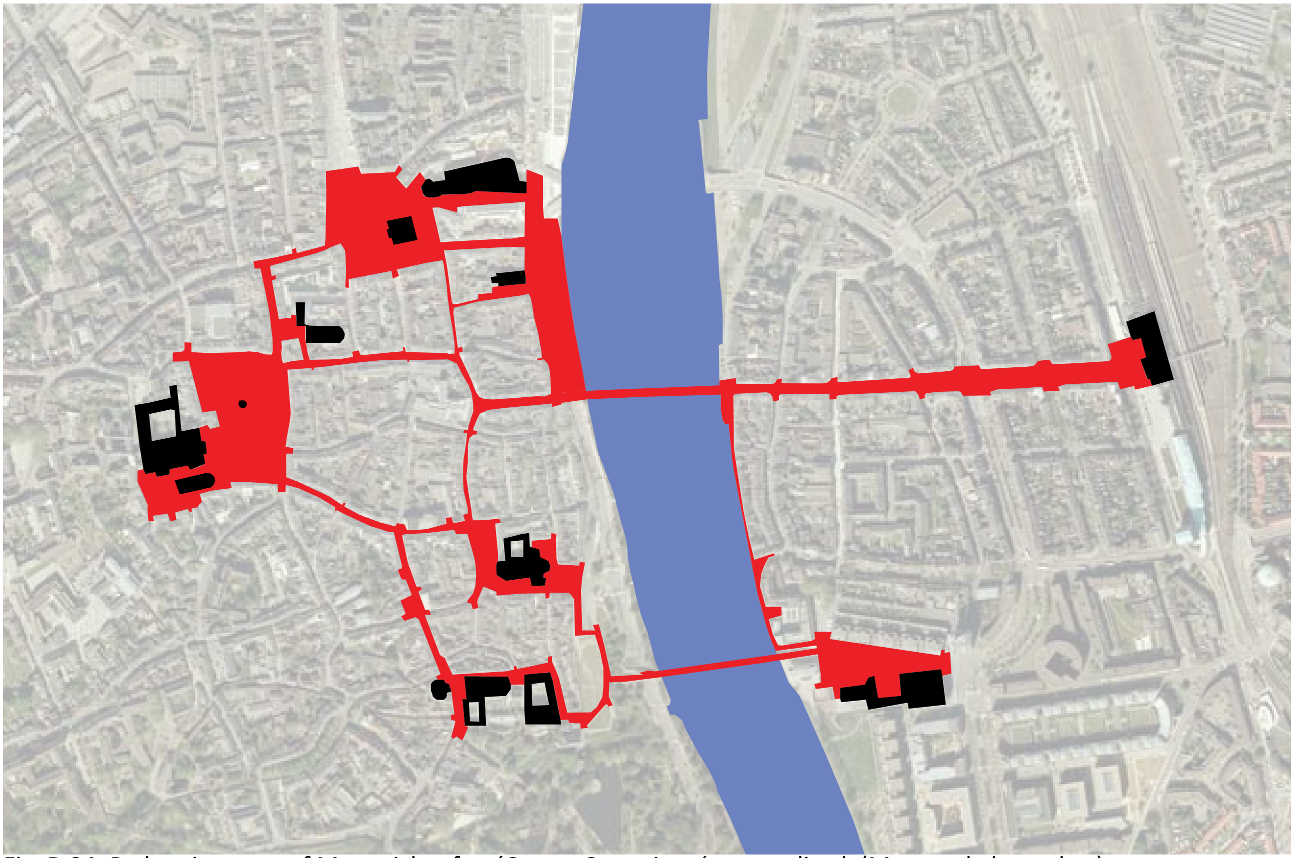


Fig. D.24: Pedestrian zone of Maastricht after ´Centre Ceramique´ was realised. (Map made by author)

Fig. D.25: New pedestrian bridge.
(Source: www.maastricht.nl)

Fig. D.26: 'Centre Ceramique' as new destination.
(Source: www.centreceramique.nl)

Design principles

Pedestrian access

- Create a walking route.

Activities near the river

- Add function as destination to attract people and change pedestrian flow.

Connections along riverfront

- Create connections between opposite sides of the river.

NIJMEGEN

Fig. D.27: Current situation Nijmegen. (Map made by author)

Fig. D.28: Aerial view of Nijmegen. (Source: Google Earth)

Fig. D.29: View on the quay. (Source: www.nijmegen.nl)

Inhabitants | 160,000

River | Waal

Pedestrian access

- Pedestrian zone includes the riverfront.
- No infrastructural barriers between center and river.

Visual link

- Altitude difference between city center and riverfront.

Activities near the river

- Restaurants and bars
- Museums
- Casino
- Space for events

Connections along riverfront

- Weak connections with harbor and nature area.
- Park 'Valkhof' next to the riverfront.

Pedestrian access and visual link

Fig. D.30: Pedestrian zone reaches the riverfront.
(Map made by author)

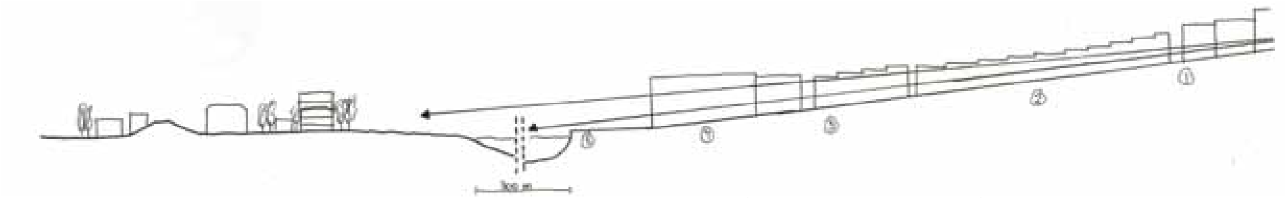


Fig. D.31: Altitude difference makes the river visible from the center. (Map made by author)

Fig. D.32: View from position 1 in pedestrian map.
(Map made by author)

Fig. D.33: View from position 2 in pedestrian map.
(Map made by author)

Activities near riverfront

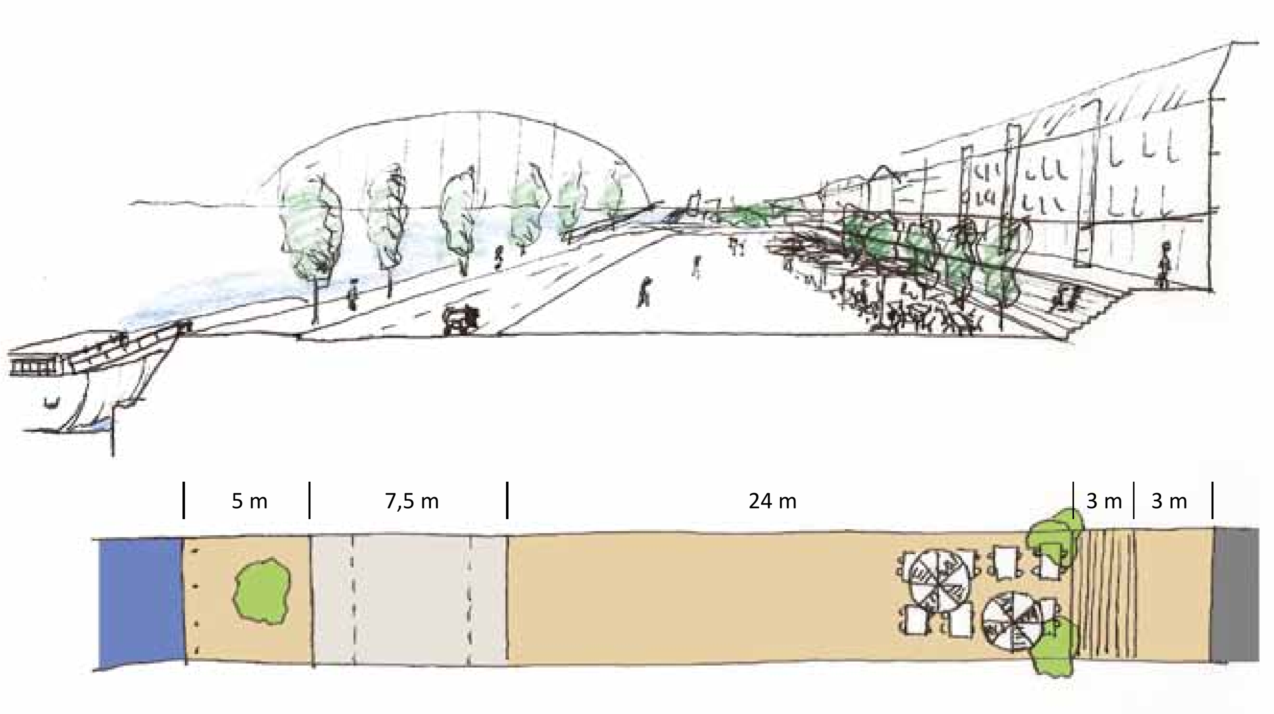


Fig. D.33: Space for terraces and events on the quay. (Map made by author)

Fig. D.34: Park 'De Valkhof' at the end of the riverfront. (Source: www.nijmegen.nl)

WAALSPRONG AND WAALFRONT

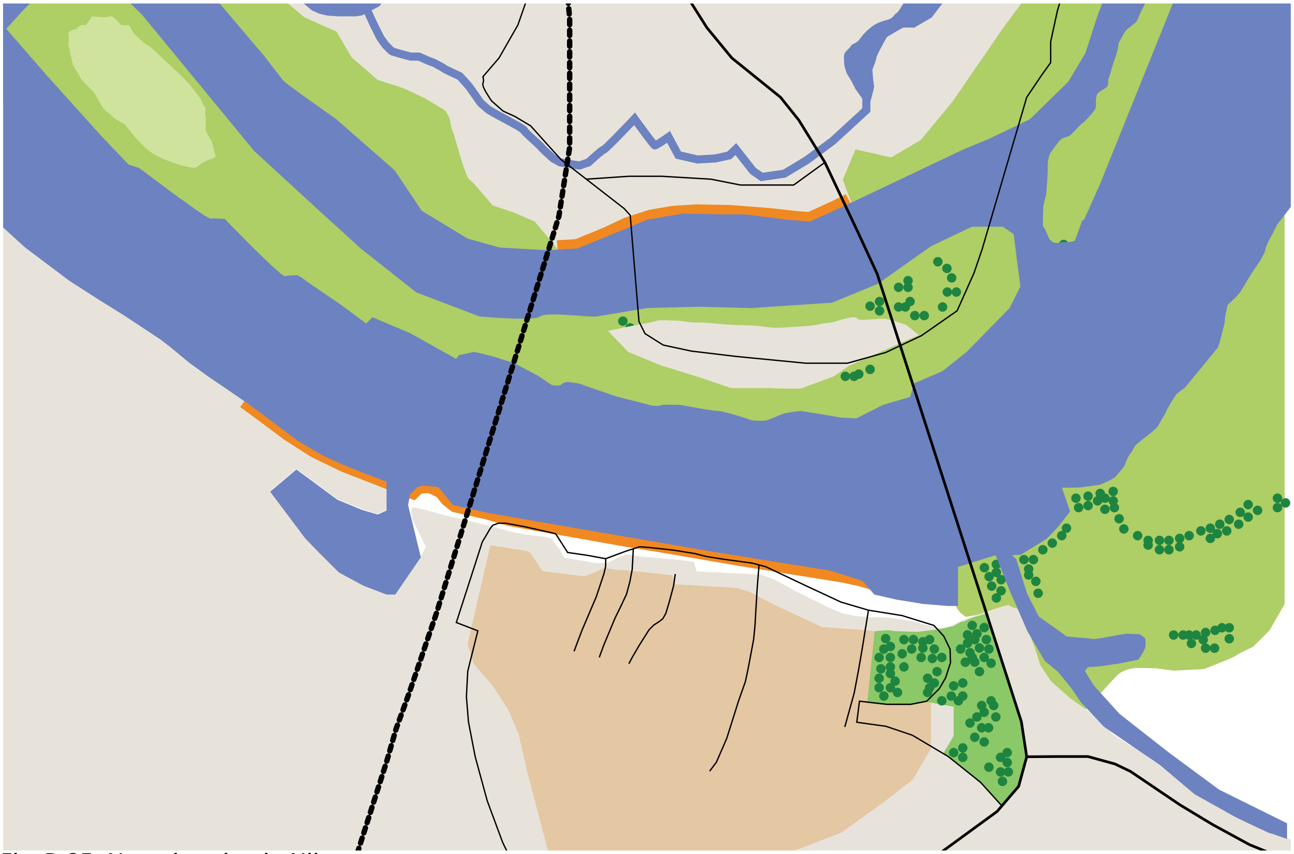


Fig. D.35: New situation in Nijmegen.
(Map made by author)

Fig. D.36: The Waalfront project extends the riverfront .
(Source: www.nijmegen.nl)

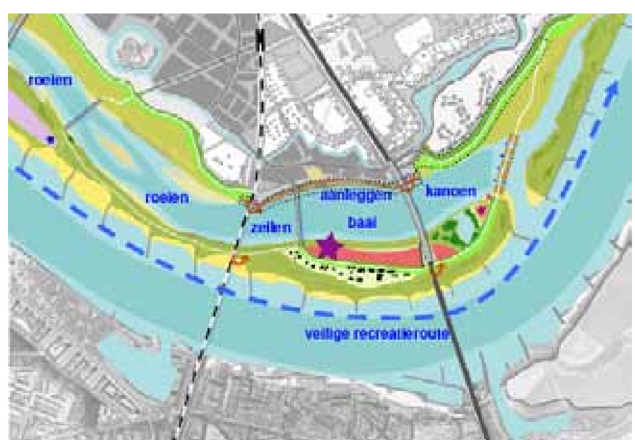


Fig. D.37: The Waalsprong project with different kinds of riverbased functions. (Source: www.waalsprong.nl)

Design principles

Activities near the river

- Add function as destination to attract people and change pedestrian flow.
- Create space for terraces and/or events.
- Create possibility for riverbased functions.

Connections along riverfront

- Create network through the river’s nature area.
- Extend the public riverfront.

VENLO

Fig. D.38: Current situation Venlo. (Map made by author)

Fig. D.39: Aerial view Venlo. (Source: Google Earth)

Fig. D.40: Riverfront of Venlo. (Source: www.venlo.nl)

Inhabitants| 35,000

River| Maas

Pedestrian access

- Pedestrian zone close to the riverfront.
- Infrastructural barriers between center and river.
- Distance between inner city and riverfront 100 metres.

Visual link

- Street pattern orientated on the river.
- High quay.

Activities near the river

- Restaurants and bars
- Theatre
- Parking
- Harbor

Connections along riverfront

- Industrial area and residential area.

Pedestrian access and visual link

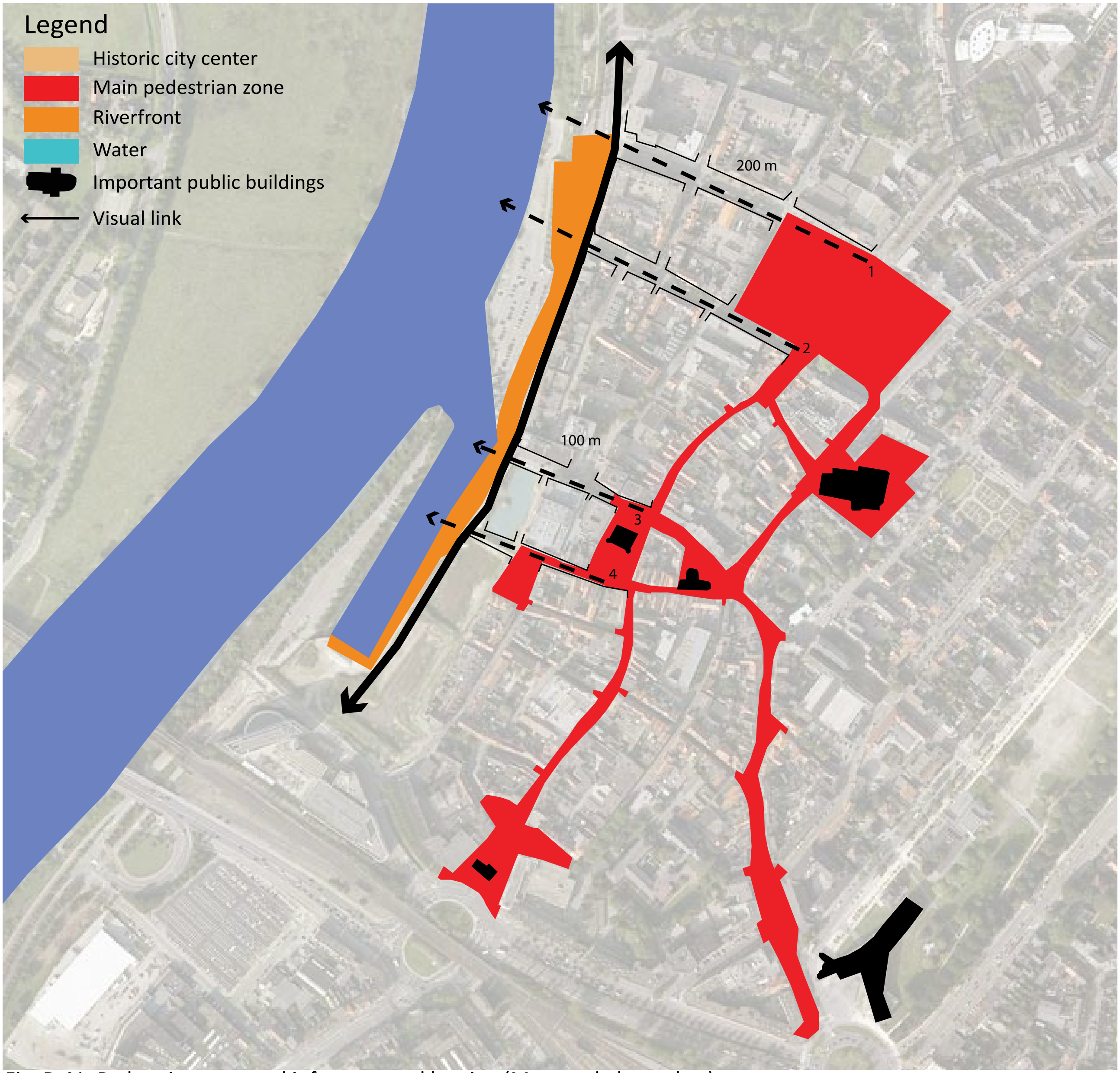


Fig. D.41: Pedestrian zone and infrastructural barrier. (Map made by author)

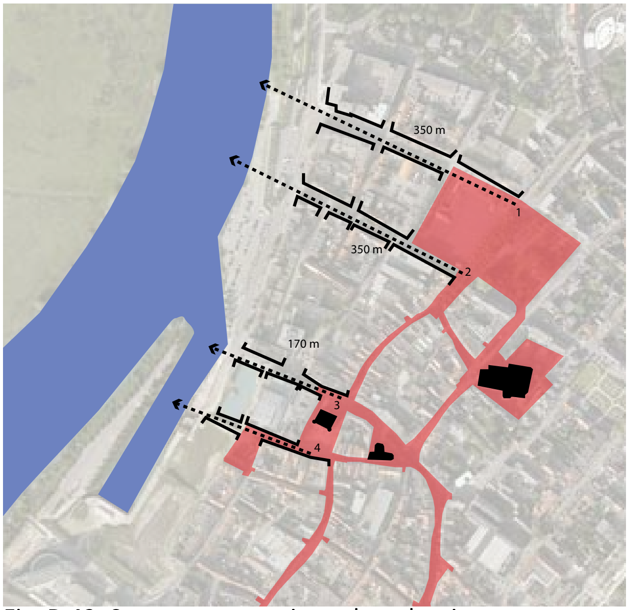


Fig. D.42: Street pattern oriented on the river.
(Maps made by author)

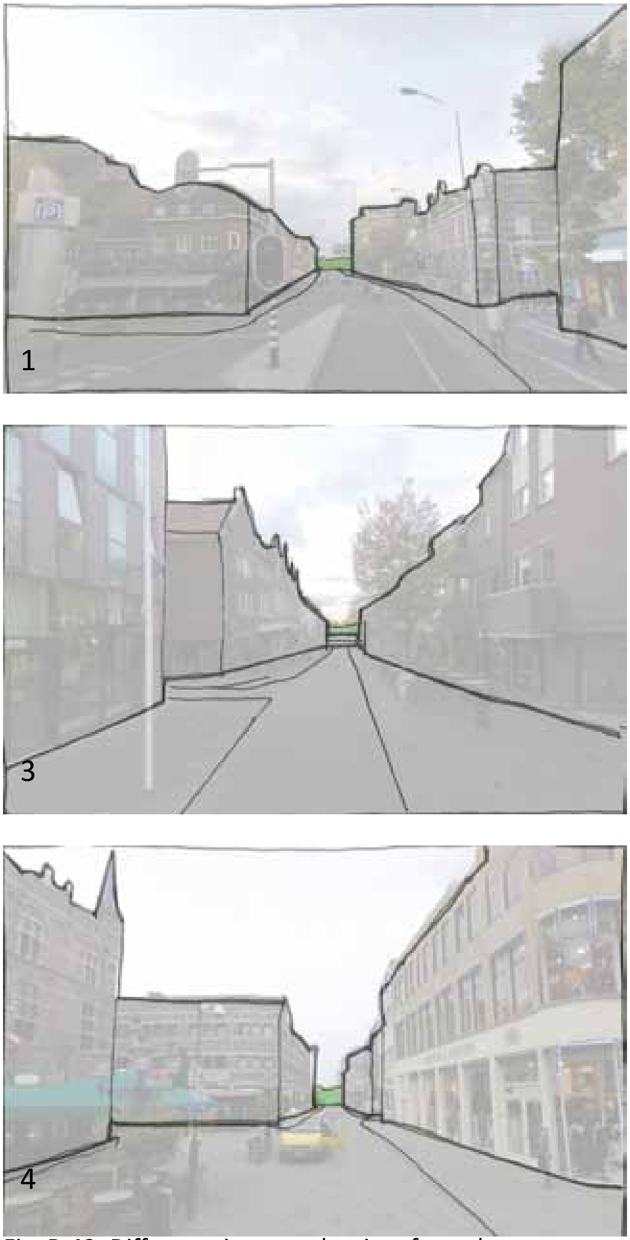


Fig. D.43: Different views on the river from the center.
(Maps made by author)

MAASBOULEVARD

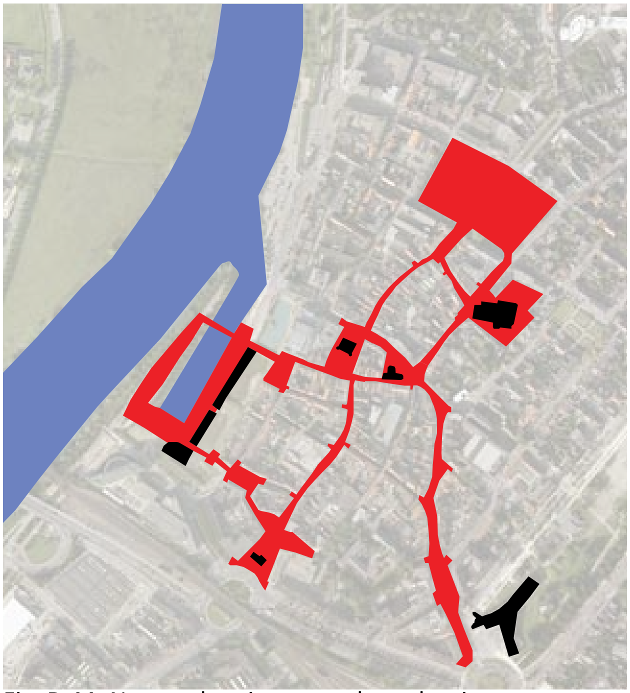


Fig. D.44: New pedestrian zone along the river. (Map made by author)

Fig. D.45: Impression of the new 'Maasboulevard' with new pedestrian bridge and functions around the harbor. (Source: www.maasboulevard.nl)

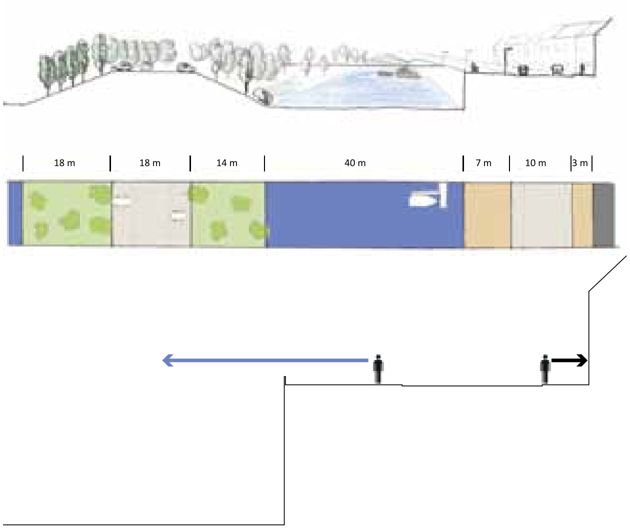


Fig. D.46: Current quay. (Maps made by author)

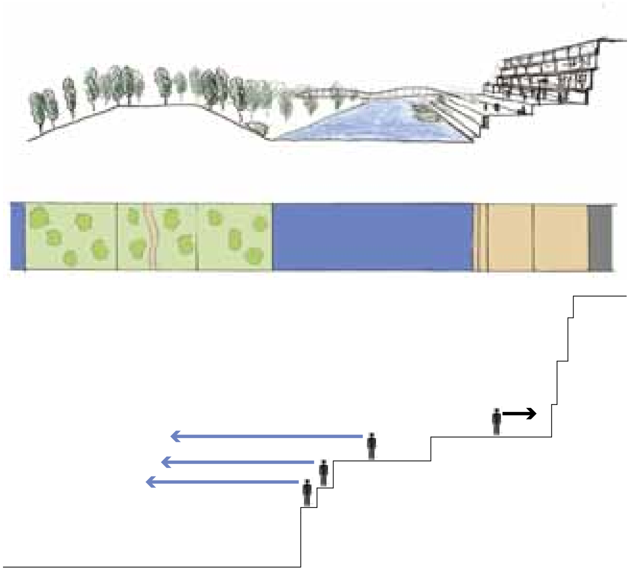


Fig. D.47: New quay. (Maps made by author)

Design principles

Pedestrian access
- Reorganise public space.
- Redesign public quay.
- Create walking route.

Pedestrian access
- Orient street pattern on river.
- Different height levels quay.
- Removing obstacle.

Activities near the river
- Add function as destination to attract people and change pedestrian flow.
- Create space for terraces and/or events.

RESULTS CASE STUDY

Pedestrian access

Spatial elements

Pedestrian zone
Infrastructural barriers
Different building tyopologies
Distance between city center and riverfront

Visual link

Spatial elements

Street pattern
Altitude difference between city center and riverfront
Obstacles

Activities near the river

Spatial elements

Destinations
Riverbased functions
Different building types along the quay
Zones with different functions

Connections along riverfront

Spatial elements

Kinds of surrounding areas
The way surrounding areas are connected

Design principles

Reorganize public space
Restructure infrastructure
Create a walking route
Redesign public quay

Design principles

Orient street pattern on river
Different height levels quay
Water into the city
Removing obstacles

Design principles

Add function as destination to attract people and change pedestrian flow
Create space for terraces and/or events
Create possibility for riverbased recreation
Relate functions to the different building types
Create different functional zones

Design principles

Create network through the river's nature area
Extend public riverfront
Create connections between opposite sides of the river