NOT JUST A CORRIDOR

Ecological landscape design for the Panke River in Berlin to improve both the natural ecosystem and environmental justice

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Hylke Warmerdam

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Colofon

Graduation thesis report

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All pictures, images and drawings in this graduation report have been made by the author, unless stated otherwise.

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Abstract

In urban areas, river courses have often been modified to a large extent to meet human needs. This modification has led to a decrease in ecological quality and biodiversity at both local and regional scales. Berlin is an example of a city with substantially modified rivers and decreased biodiversity. Rivers have been modified the most in dense neighborhoods near the city center. There is a need to improve urban river ecosystems in the context of a nationwide and worldwide decrease in biodiversity. The importance of urban green spaces increases for people in cities as well in the context of climate change. However, green spaces and their benefits are not equally distributed throughout the city, with socio-economically disadvantaged people generally having poorer access to green spaces and suffering more from environmental stress factors, such as noise pollution and heat stress. This environmental justice problem can be mitigated by making neighborhoods greener, but open space is often rather limited in the city. Therefore, this graduation project aimed to improve the ecological value of rivers and environmental justice simultaneously with ecological design for existing green spaces. The project focuses on the Panke River, a highly modified river that flows through neighborhoods with a substantial environmental justice problem. Design principles have been formulated based on scientific theory about ecological design and design for equitable green space access. These principles were combined in a design vision for a small area along the Panke River in the district Gesundbrunnen. The resulting design showed that it is possible to significantly improve both the ecological value of river ecosystems and environmental justice with ecological design for existing green spaces. The Panke River can be both an ecological corridor and a green structure that connects neighborhoods. The diverse riverbank landscape with an alternation of ecological and recreational focus areas is a high-quality public green space with improved ecological quality.

Keywords
Urban ecology, river ecosystem, urban river corridor, ecological corridor, biodiversity, environmental justice, ecological design

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1 Introduction

Figure 1.1. Panke River in Berlin (Hansen, 2019)

Figure 1.2. The Panke River in Berlin Gesundbrunnen

The degradation of urban river ecosystems

Cities and rivers

Worldwide, many cities have been founded next to rivers or in deltas. Rivers provide a large range of services: the possibility for transportation, fresh water for drinking, sanitation, and industries, defense, and power for early industrial processes.

Modifications of river ecosystems

Humans have modified rivers for their purposes. Rivers have been modified to protect settlements from floods, sewage systems have been built, and waterpower has been used for early industrial processes (Grimm et al, 2008). Streams are often straightened and controlled with locks, weirs, and dams, and banks have been reinforced.
Humans have also changed the land use around rivers. Natural habitats have been replaced by agricultural land, buildings, and infrastructure. The increase in impervious land cover is one of the most significant changes (Grimm et al., 2008). Where precipitation is still drained by rivers, water is discharged in larger and more abrupt volumes. Pollutants from roads and buildings in drained into streams.

Degradation of urban rivers

Human adaptations are aimed at improving certain ecosystem services, such as flood defense. Other ecosystem services are often degraded or lost and the original aquatic ecosystem is changed (Grimm et al, 2008). Ecological quality and biodiversity have been decreased (Everard & Moggridge, 2011), at both local and regional scales (Francis, 2012). The value of the lost ecosystem services is “often overlooked” (Baron et al, 2002). Nevertheless, urban rivers continue to be important features within both the physical and cultural landscapes of urbanized areas. Rivers are central to the identity of many towns and cities (Francis et al, 2012).

Restoration of urban ecosystems

The awareness of long-term and short-term economic and societal benefits of “intact and biologically complex aquatic ecosystems” is growing (Baron et al, 2002). The need to protect and preserve river ecosystems is rising (Everard & Moggridge, 2011).
The European Union adopted the Water Framework Directive in the year 2000. It was a reaction to the concerns about the state of the water in Europe. The goal of the directive is to improve the quality of water. The quality of the river Panke must be improved as well. “However, achieving a good ecological state is hardly possible for many urban rivers. Therefore, the European Water Framework Directive has established a further classification, the Heavily Modified Water Bodies which are water bodies that have significantly changed their original appearance. These Heavily Modified Water Bodies have to achieve a good ecological potential rather than a good ecological status (Lange et al, 2015).”

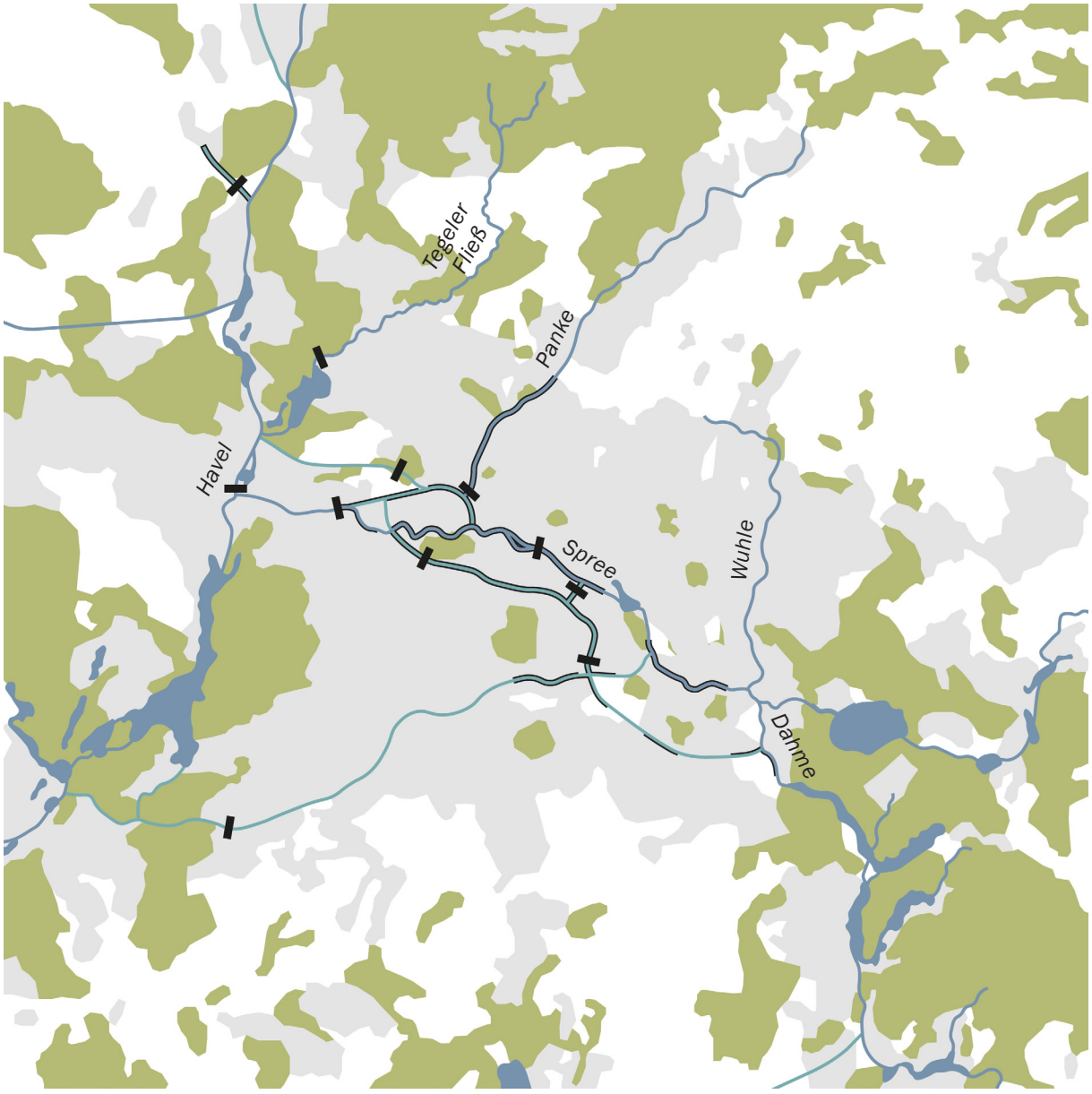


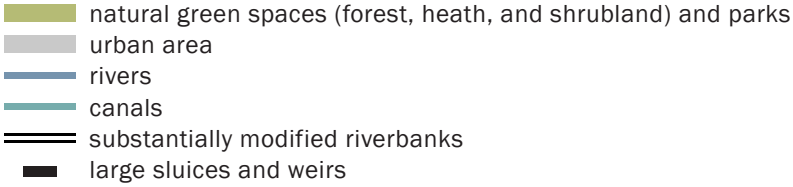
Figure 1.3. River ecosystems in Berlin

The degradation of river ecosystems in Berlin

Berlin is an example of a city along a river. The city has been founded in the 13th century, as a merchant settlement along the Spree River. Today, the rivers of Berlin have been modified to a large degree. Locks, weirs, dams, water extraction, sewage systems, dams, and canals influence the flow of water. Since the late middle ages, weirs have been installed to power water mills. From the 17th century onwards, rivers have been straightened to allow faster shipping. The needed dams and weirs form became an obstacle for migratory fish. During the 19th and 20th centuries, the discharge of industrial wastewater and sewage water into the rivers of Berlin led to a sharp decrease in fish abundance (Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2013). A large part of natural river banks have been reinforced with sheet piles and walls. Traffic, lighting, intensive land management and recreation are other threats to biodiversity in the city (Senatsverwaltung für Stadtentwicklung und Umwelt, 2015). Natural habitats have been lost or disconnected.

During the last decades, as the awareness of the environment increased, the quality of the water in Berlin has improved. Consequently, fish abundance has gone up again (Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2013). Still, the natural ecosystem is far from restored (Senatsverwaltung für Stadtentwicklung und Umwelt, 2015).

Figure 1.3 clearly shows that the city of Berlin forms an obstruction in the larger ecosystem. West and east of the city, the rivers and lakes are surrounded by forests and wetlands. In the city, the Spree River and its tributaries are substantially modified. Large parts of the rivers have been canalized. The landuse has changed and green spaces are fragmented.



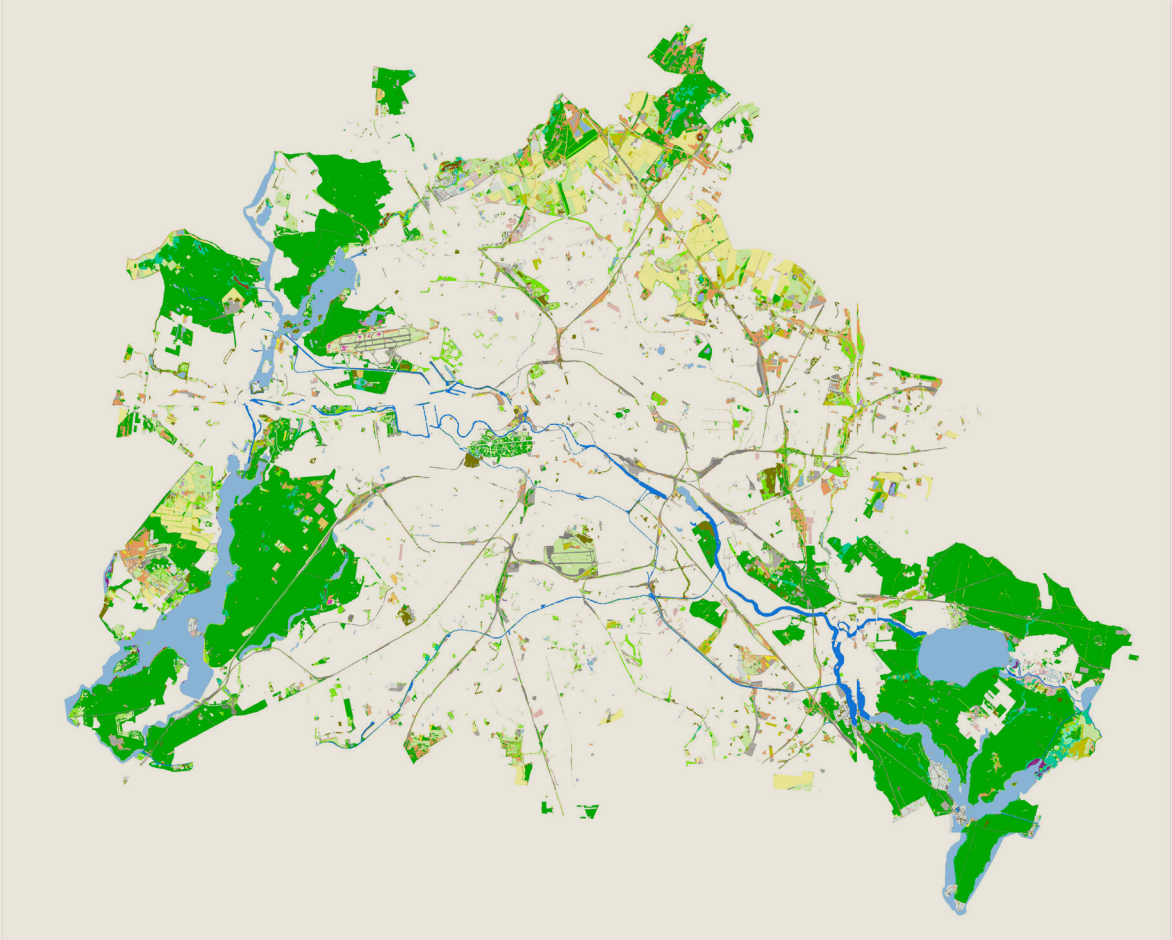


Figure 1.4. Biotypes in Berlin (Senatsverwaltung für Stadtentwicklung und Umwelt, 2015)

0 5 25 km N

Biotypes

44% of the land surface of the state of Berlin is covered with green spaces and water (figure 1.4). Forests make up 18% of the total land area, with water and parks both accounting for 7%, and agricultural land making up 4%. An estimated 20.600 flora and fauna species live in Berlin. (Senatsverwaltung für Stadtentwicklung und Umwelt, 2015). The highest quality biotopes are located in the forests at the edge of the state (Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2013) (figure 1.5).

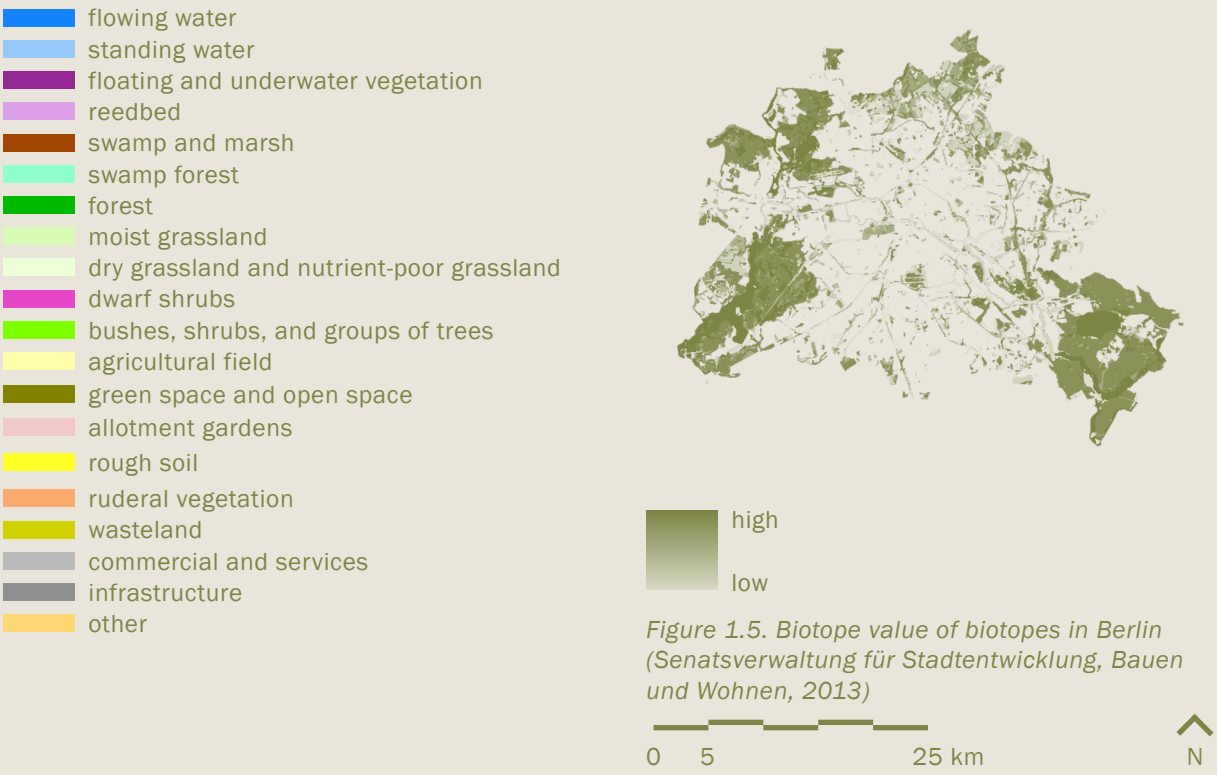


Figure 1.5. Biotope value of biotopes in Berlin (Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2013)

European Water Framework Directive

In June 2000, after a process of 12 years, the European Parliament's and Council's conciliation agreed on the Water Framework Directive (Kallis & Butler, 2001). The directive defines the goals and approaches to managing waters in the European Union. The main goal of the directive is to improve the quality of water throughout the union. By 2027, all member states of the EU have to make sure that all water is in a good ecological and chemical state. The EU has acknowledged that achieving a good state is hardly impossible for many urban rivers. Therefore, the so-called "heavily modified water bodies have to achieve a good ecological potential rather than a good ecological status (Lange et al, 2015)."

In 2007, the provinces of Berlin and Brandenburg started a joint pilot project to improve the ecological quality of the Panke River from the source to the river mouth. Not only the morphology of the river has to be improved. Heavy metals, nutrients, and rainwater peaks are threats to the ecological quality of the river. The pilot project aims at renaturalizing the river course and improving water quality. (Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt, n.d.). The first steps are taken. Several constructed fish ladders (figure 1.6) have had a positive effect on the number of fish. Other than that, most interventions proposed by the Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz (2015) have not been completed yet. In the meanwhile, other projects have been launched in the city. However, if Berlin wants to comply with the Water Framework Directive, more action is needed in the coming years.

Figure 1.6. Fish ladder in the Panke River in Schlosspark Niederschönhausen (Geißler, n.d.)

Biodiversity crisis and climate crisis

Ecological degradation of river ecosystems is part of a larger-scale problem. During the last 50 years, the abundance of species diversity in Germany has decreased by around one-third (Heinrich Böll Stiftung et al., 2019) (figure 1.7). Urbanization is one of the main reasons for biodiversity decline. Therefore, there is a need to restore river ecosystems in Berlin.

The availability of green spaces is important for people as well. Vegetation mitigates heat stress and green spaces are cool places to go to on warm days. The annual average daily highest temperature has gone up by one degree since the seventies (Senatsverwaltung für Stadtentwicklung und Umwelt, 2016). The temperature rise is expected to speed up during the next decades. Therefore, vegetation and green spaces that mitigate heat stress are becoming increasingly important.

The population of Berlin has increased by 20 percent during the last five decades (Amt für Statistik Berlin-Brandenburg, n.d.) and will keep increasing in the near future (Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2022). Urban densification can form a threat to the existence of green spaces and leads to more intensive use of existing green spaces.

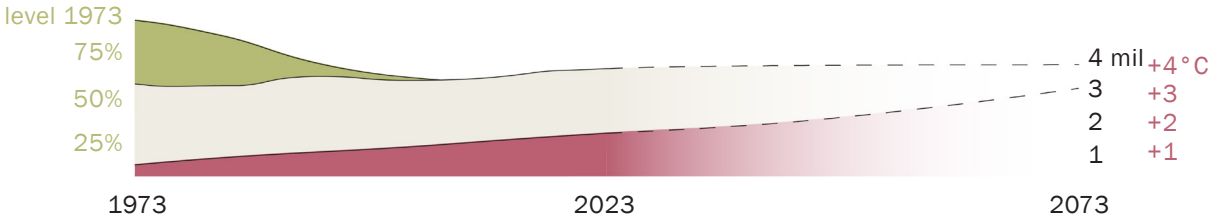


Figure 1.7. Biodiversity level compared to 1970 (Heinrich Böll Stiftung, 2019), population growth 1973-2040 (data sources: Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2022; und Amt für Statistik Berlin-Brandenburg, n.d.) and annual average daily highest temperature, change opposite to the average of 1970-2000 (data source: Senatsverwaltung für Stadtentwicklung und Umwelt, 2016)

Figure 1.8. Rosenthaler Platz in Berlin (source: Sehr, 2014)

Environmental justice

A greener city might lead to better-functioning ecosystems and increased biodiversity. But green spaces are important for humans as well. Green spaces and trees improve health and mitigate the climate (Konijnendijk, 2022). As a result of climate change, green spaces become even more important for public health than they are now. It raises the question: is access to green spaces equally distributed in the city? This is a question about environmental justice.

Environmental justice is a concept about the unfair distribution of environmental threats and amenities. It is about offering everyone a clean and healthy environment to live and work in. The first time that the concept of environmental justice was widely used, was in the 1980s in the United States (Mohai et al., 2009). In the 1980s, action groups started to create awareness about social justice. They pointed out that people of color and poor communities were exposed to larger environmental risks than the white middle class (Mohai et al., 2009). Scientific studies on the topic of environmental justice followed. It was soon concluded that indeed, environmental justice was lacking (Brulle & Pellow, 2006; Mohai, 2009) "(...) in general, ethnic minorities, indigenous persons, people of color, and low-income communities confront a higher burden of environmental exposure from air, water, and soil pollution from industrialization, militarization, and consumer practices" (Mohai, 2009). "Both the concept and its coverage have expanded substantially in the past two decades" (Schlosberg, 2013) and the concept is used in different ways. The focus has shifted from "the distribution of environmental bads" in the 1980s to "just sustainability" in daily life (Schlosberg, 2013; Antal, A., 2022). Environmental justice gained the attention of policymakers, often named environmental racism, environmental inequality, or environmental inequality (Mohai, 2009).

According to the WHO (2012, in de Vries et al., 2020), environmental justice has three aspects. A distributive, procedural, and recognitional aspect. Distributive justice is about the "spatial distribution of environmental risks and amenities and the resulting disparities among socioeconomic and racial groups". This graduation project is about spatial design and will therefore focus mainly on the distributive aspect.

The lens of environmental justice can help to enrich the design of a river. A river with improved ecological quality can also provide greenspaces to the people who need them the most. Chapter 2, Theory and research framework, provides the theoretical basis for designing an improved river ecosystem and improved environmental justice.

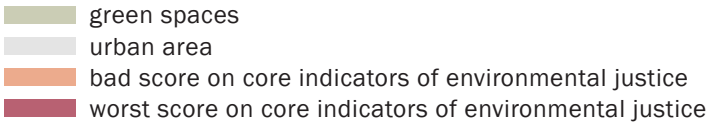
Figure 1.9. Green spaces and environmental justice in Berlin (data source: Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, 2022)

Environmental justice in berlin

Berlin has mapped environmental justice in the city since 2008. In 2022, the Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, together with Amt für Statistik Berlin-Brandenburg and the Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, has produced new maps of the status of environmental justice in Berlin (Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt, 2022). With the maps, the relationship between environmental quality and social index is made.

According to the report, environmental justice in Germany is mainly caused by economic inequality. People with a lower economic situation and lower education tend to be exposed to more environmental stress factors (Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt, 2022). The used main parameters are noise pollution, air pollution, bioclimatic burden (heat stress), access to green and open spaces, and social deprivation. Additional indicators are population density and the quality of residential areas. Noise pollution is caused mainly by road and railroad traffic. Road traffic has a strong relation with air pollution as well. Air pollution is the most problematic in the city center and less problematic at the outskirts. heat tress is a problem of dense neighborhoods, both in the center and in outskirts. Access to green spaces is best for neighborhoods in the peripheral part of the city and neighborhoods with lower building density. Areas with a low social status are found in different parts of the city.

Many areas in Berlin have high levels of both environmental stress factors and social problems. This is mostly a problem of dense areas in the city center. But there are some areas in the periphery of the city that suffer from the same problem. (Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt, 2022). People with low social-economical status are more often exposed to environmental burdens. (Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, 2022). The map (figure 1.9) shows the areas that score the most problematic on the combination of the main parameters. A few areas around the city center stand out. But the problem does not only concentrate in the center.



Berlin’s environmental justice map

In 2022, the responsible Senate Department updated the environmental justice map of Berlin (Senatsverwaltung für Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, 2022). To make the final map, 5 main indicators were used.

Figures 1.10 to 1.14 show the relative occurrence of the indicators noise pollution, air pollution, thermal stress, green space supply, and social disadvantage. Figure 1.15 is the sum of these indicators. Figure 1.16 shows the ‘integrated’ environmental justice map, completed with population density and housing quality.

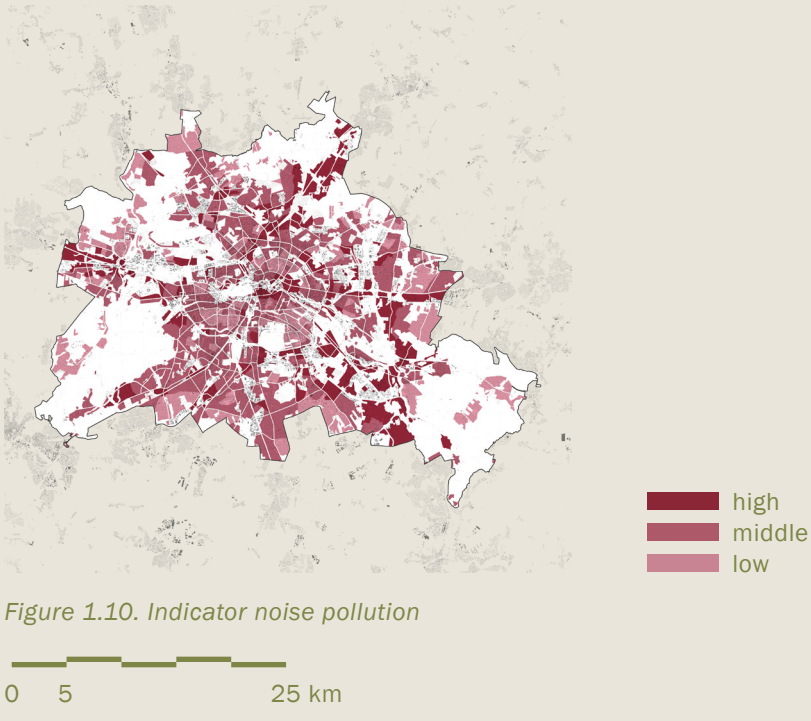


Figure 1.10. Indicator noise pollution

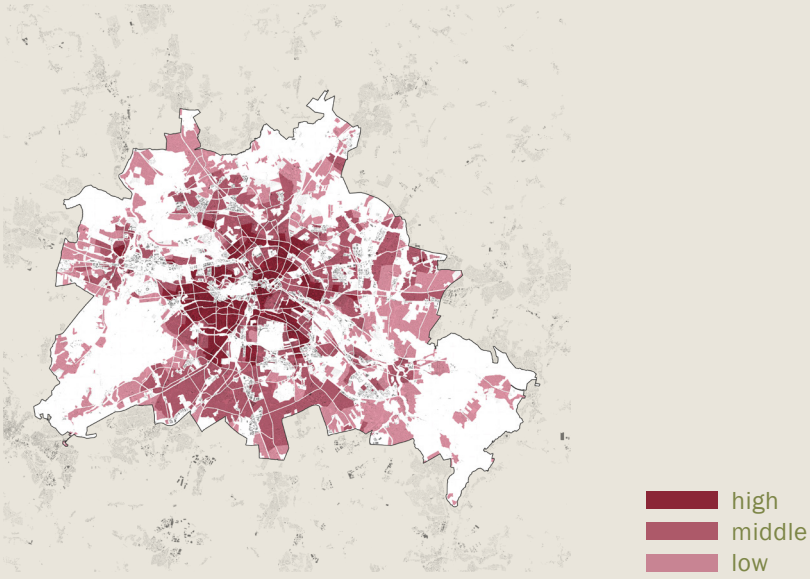


Figure 1.11. Indicator air pollution

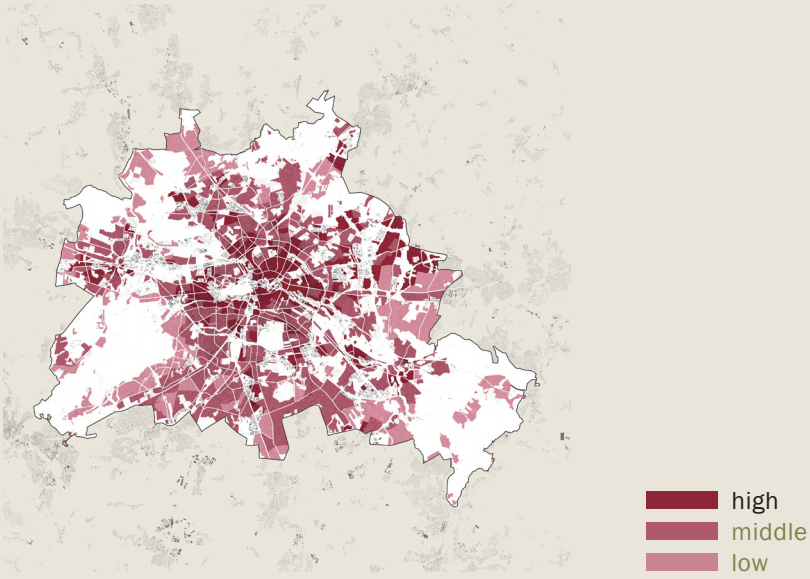


Figure 1.12. Indicator thermal stress

N

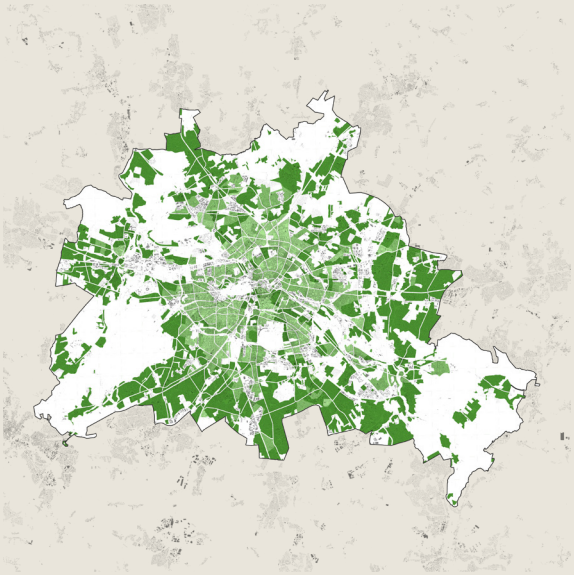


Figure 1.13. Indicator green space supply

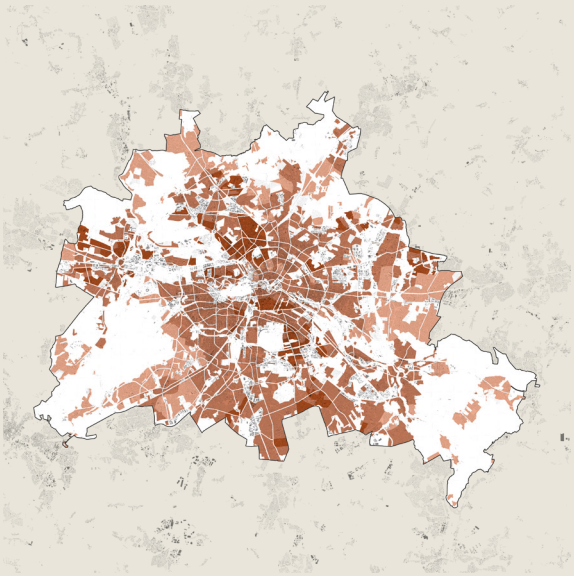


Figure 1.14. Indicator social disadvantage

0 5 25 km

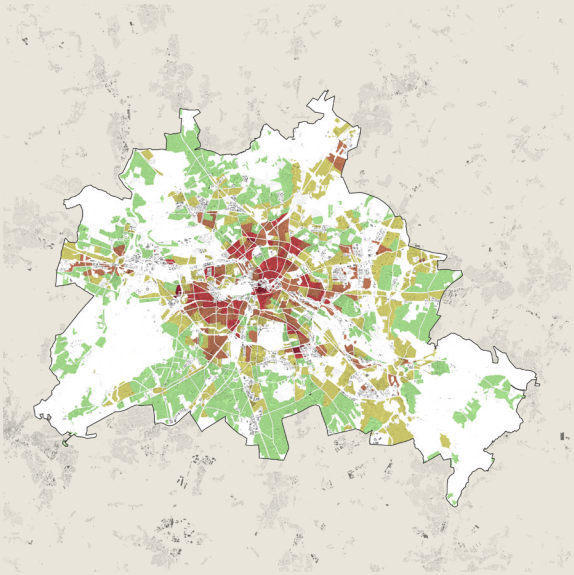


Figure 1.15. Multiple burdens

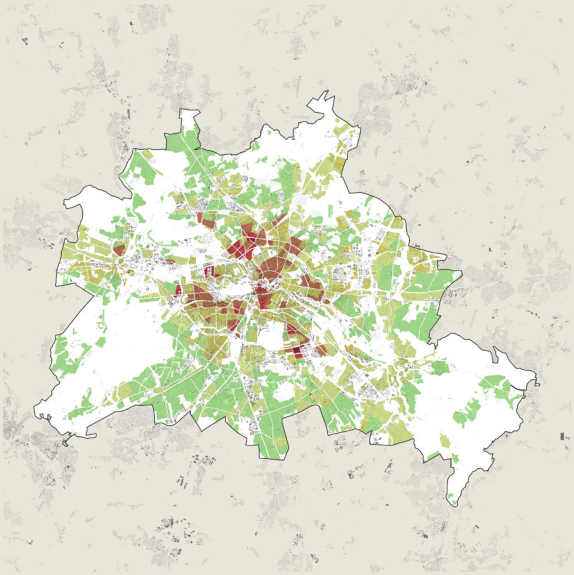


Figure 1.16. Integrated environmental justice map

N

Figure 1.17. The River Panke and connected natural areas and areas with a bad score on core indicators of environmental justice (data source: Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, 2022)

Selection of the Panke River

Since the aim of this thesis is to improve both the ecological value of river ecosystems and environmental justice, it is logical to select an area where both the ecological situation and environmental justice are problematic. The Panke River is an excellent research location. The small 29-kilometer-long river flows through the suburbs of Berlin, towards the city center, and connects to vast natural areas on the edge of the city. The Panke River does also flow through areas with substantial environmental justice issues (figure 1.17). In these areas, the river is entirely canalized. There is a need to improve both the natural ecosystem and environmental justice along this river, more than elsewhere in Berlin. The river is described in Chapter 3.

water
Panke
substantially modified riverbanks
green spaces
green spaces connected to the river Panke
urban area
bad score on core indicators of environmental justice
worst score on core indicators of environmental justice

Conclusion

Urbanization has led to the degradation of river ecosystems in Berlin, leading to biodiversity decline. Although the situation has improved during the last decades, natural ecosystems are far from restored. In the context of climate change, the availability of green spaces is not only ecologically important but also important for human well-being in cities. Access to green spaces and their benefits is unequally distributed within the city. In other words, Berlin has an environmental justice issue.

The Panke River is selected as the research location for this graduation project. The spatial structure of the Panke River does not provide optimal spatial conditions for both the natural ecosystem and environmental justice. Figure 1.18 summarizes the problem. The objective of this graduation project is to design optimized spatial conditions for the Panke River to enhance the value of the natural ecosystem and to promote environmental justice in Berlin. Figure 1.19 summarizes the research question.

Problem statement

The spatial structure of the Panke River in Berlin does not provide optimal conditions for both the natural ecosystem and environmental justice.

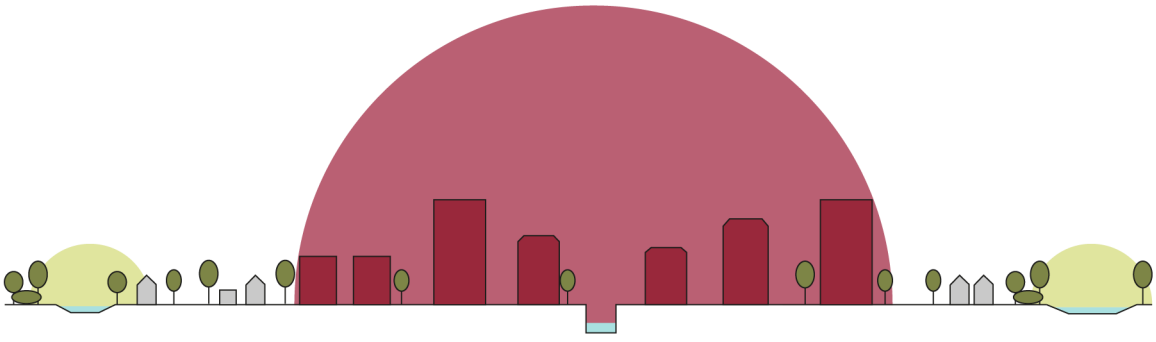


Figure 1.18. No optimal spatial conditions for both the natural ecosystem and environmental justice

Research question

How can ecological landscape design of the Panke River in Berlin provide optimized spatial conditions for both the natural ecosystem and environmental justice?

To answer the main question, the following sub-questions will be answered.

1. Problem analysis
A. What are the spatial characteristics of river ecosystems in Berlin?
B. What are the spatial characteristics of environmental justice in Berlin?

2. Theory
A. How can the ecological value of rivers be improved in an urban context?
B. How can environmental justice be improved in an urban context?

3. Analysis
A. What are the limiting spatial conditions of the Panke River as a natural ecosystem?
B. What are the limiting spatial conditions for environmental justice along the Panke River?

4. Vision and design
A. How can ecological landscape design provide optimized conditions for the natural ecosystem of the Panke River in Berlin?
B. How can ecological landscape design provide optimized conditions for environmental justice along the Panke River in Berlin?

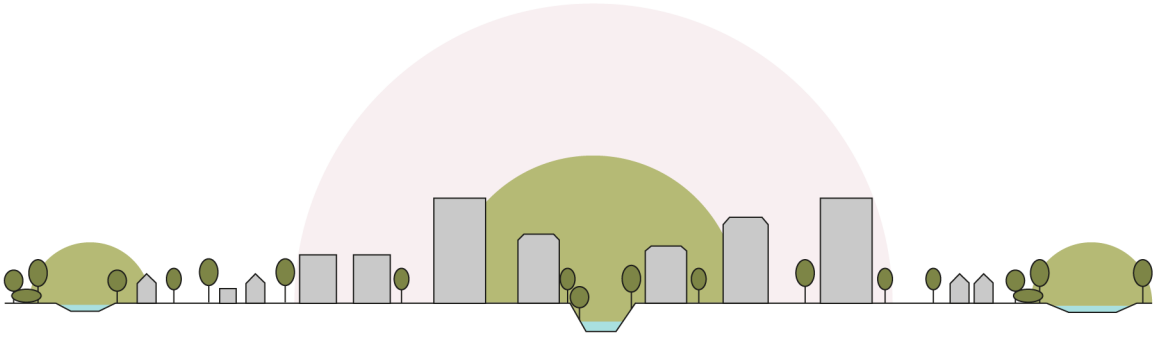


Figure 1.19. The aim of this graduation project is to design optimized spatial conditions for the Panke River

2 Theory and research framework

Figure 2.1. Fen meadow landscape north of Berlin (Möllers, n.d.)

Figure 2.2. Processes that cause loss and isolation of habitats

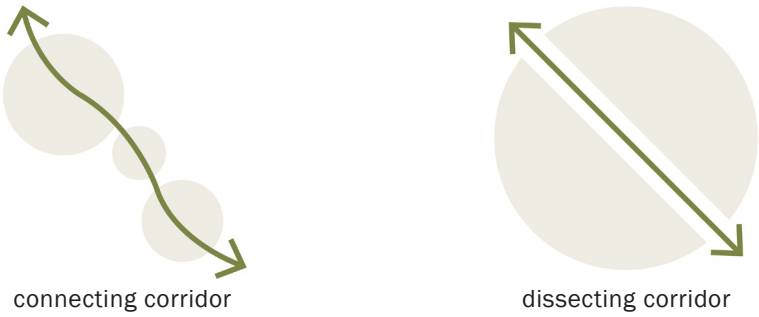


Figure 2.3. The relation between patches and corridors

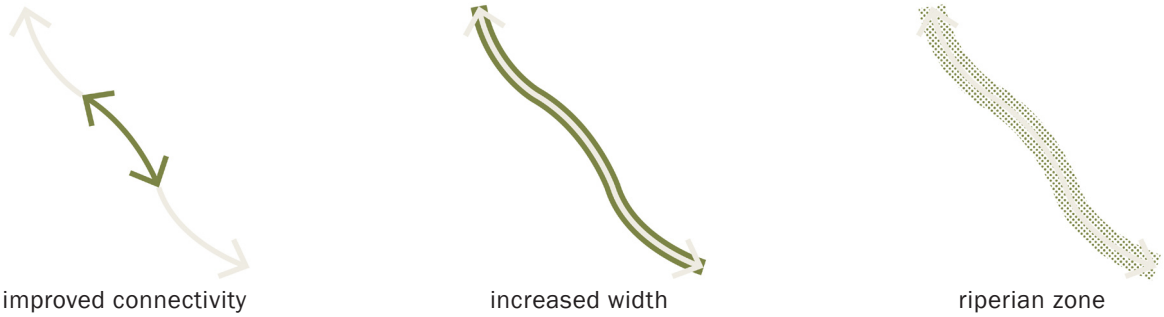


Figure 2.4. Principles for an effective river corridor

Landscape ecology principles

Landscape corridors

Biodiversity loss has several reasons. One of the main reasons is the gradual loss and isolation of habitats (Dramstad et al., 1996). Dramstad, Olson, and Forman (1996) state that landscape planners must contend with this problem to prevent further biodiversity loss. The processes in the landscape that cause the loss and isolation of habitats are fragmentation (large habitats become smaller pieces), dissection (splitting a habitat in two), perforation (creating holes in a habitat), shrinkage, and attrition (disappearance) (figure 2.2).

Although not always effective, research shows that high-quality connections between patches often lead to increased biodiversity. Connections between patches are known as ecological corridors. Corridors can function as habitats for local species and enable linear movement (Forman, 2014). Streams or rivers are a type of corridor that is “of exceptional significance” (Dramstad et al, 1996). They allow water-related species to move through the landscape. Corridors can also have a negative effect on biodiversity. Roads, railroads, and canals can form a barrier (Dramstad et al, 1996) (figure 2.3).

Design principles for corridors

Dramstad et al. (1996) formulate a few principles for effective corridors. The width and connectivity of a corridor are the most important aspects. Wider corridors with fewer interruptions are in general more effective (figure 2.4). The vegetation structure along a corridor should be similar to that of the larger pathes. For stream and river corridors, water quality is important. Vegetated banks help to clean water entering the stream or river. Wide vegetated river banks do also offer habitat to a wide variety of water, floodplain, and upland species. This transition zone between land and water is known as the riperian zone. Even wider corridors can allow for natural dynamics to be reintroduced.

A gap in a corridor is not necessarily an insurmountable problem. As long as the gap is not too large and the land use of the gap differs not too much from the corridor, species can still get across. If it is not possible to create a continuous corridor, stepping stones - a series of small patches - are the best alternative. Adding a single stepping stone at the right location can have a big impact on the effectiveness of a stepping stone network.

Using the design principles

According to Dramstad et al. (1996), the Panke River should be considered a continuous corridor in the landscape. Local design interventions have an effect on the larger ecosystem. Design interventions to improve the habitat and corridor function of the Panke River will have a different effect on different species. In general, the ecological situation can be improved by establishing a wide and continuous ecological corridor to contend with the loss and isolation of habitats.

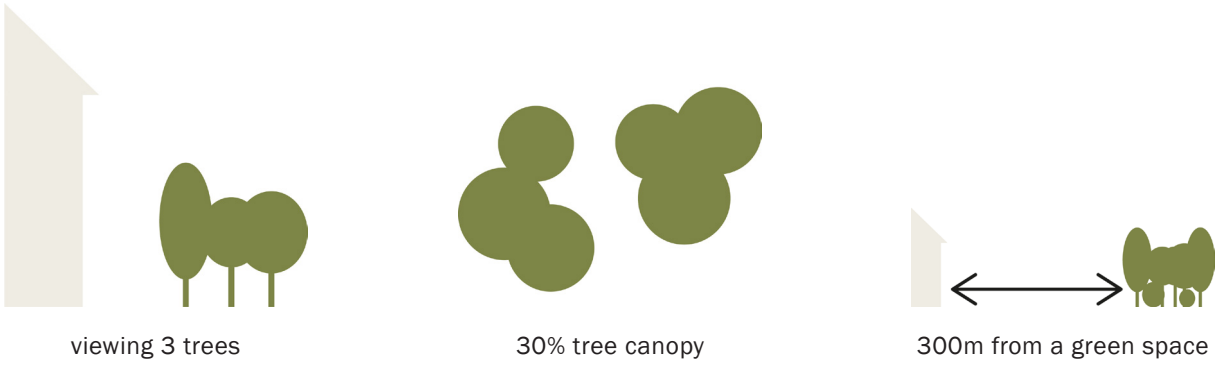


Figure 2.5. The 3-30-300 design guideline for equitable green space access

3-30-300 design guideline

Rules of thumb: 3-30-300 rule

To understand how environmental justice can be improved, the design guideline provided by Cecil Konijnendijk (Konijnendijk, 2022) can be used. Konijnendijk recognizes the unequal access to green spaces in cities as a problem. Scientific literature suggests that urban vegetation and green spaces help to address challenges such as public health, climate adaptation, pollution reduction, biodiversity conservation, and water regulation (Konijnendijk 2022). These benefits should be equally available to urban dwellers. Based on scientific theory, Konijnendijk has developed a design guideline "to ensure and optimize" equitable access. His design guideline has 3 elements: viewing trees and green spaces, living amongst green, and recreation in larger green spaces. An inspiration of Konijnendijk is the 10-20-30 guideline for urban forestry by Frank Santamour. Although this guideline has been the subject of debate, it has been very effective as a guideline. The "stickiness" might be the reason that the guideline is widely adopted (Konijnendijk, 2022). Therefore, Konijnendijk developed his own "sticky" guideline: the 3-30-300 rule (figure 2.5).

Viewing 3 trees from every home, school, and place of work

Konijnendijk admits that "the specific number '3' is not supported by scientific evidence but was chosen to connect with the numbers 30 and 300 from a communication and 'stickiness' perspective." It is based on the scientific insight that viewing green has positive short-term and long-term effects on health.

30% tree canopy cover in every neighborhood

Based on recent studies on the topic, 30% is introduced as the minimum for canopy cover in a neighborhood. To achieve cooling and health benefits, it is important to spread tree canopy equally across neighborhoods.

300m from the nearest park or green space

The third guideline is in line with the WHO recommendation to have a large public green space available within walking distance. Larger green spaces usually have more benefits than small green spaces. According to the WHO, the minimum area of a large green space is 1ha. But size is not the only requirement. A green space should be of high quality. This means that it allows for different recreational activities and has a high degree of vegetation.

Implementing the guideline

Konijnendijk stresses that it is important to be careful with implementing the design guidelines within the local context. Trees and shrubs are generally favorable, but other types of vegetation might fit better at the location.

Research framework and methods

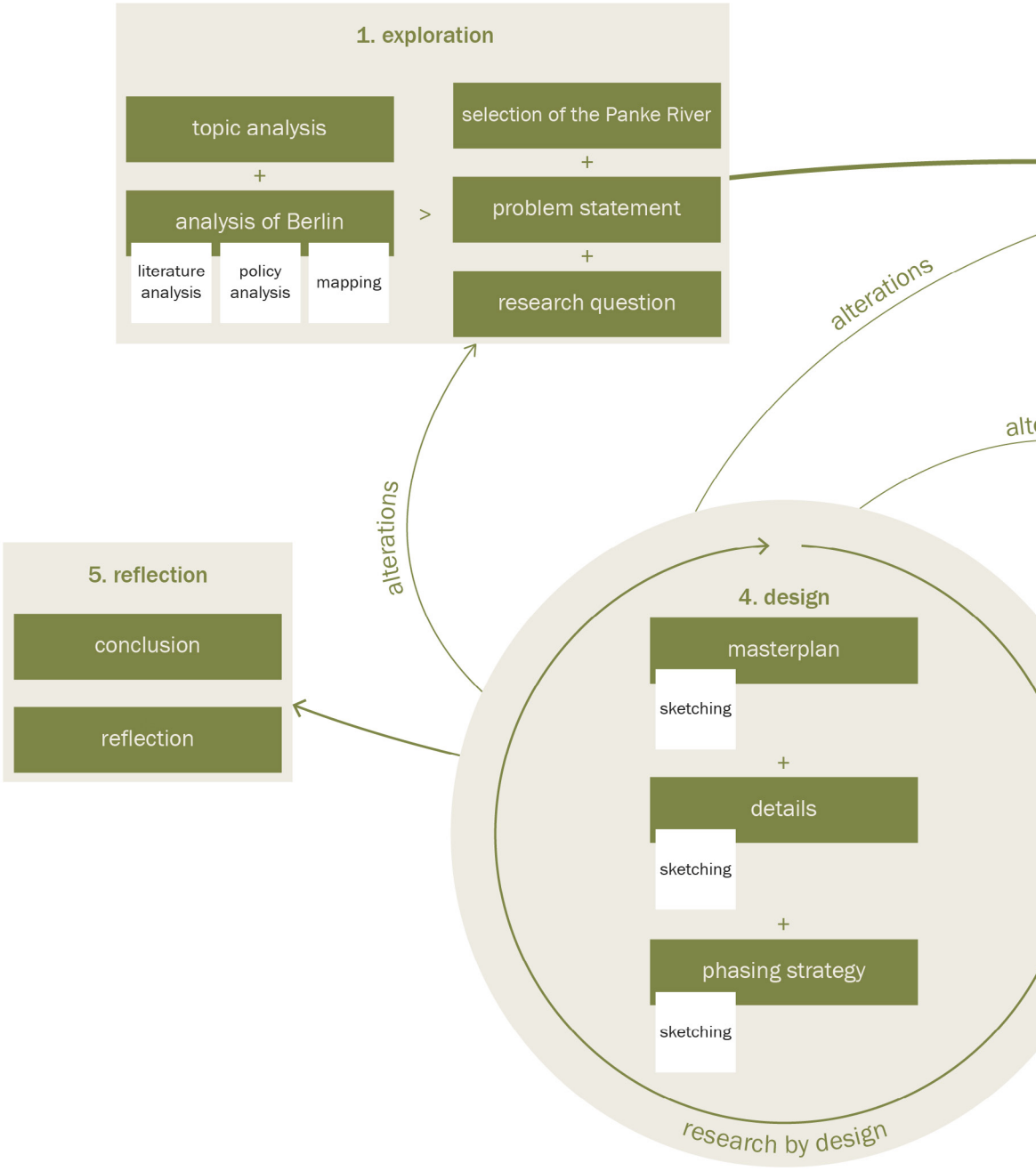
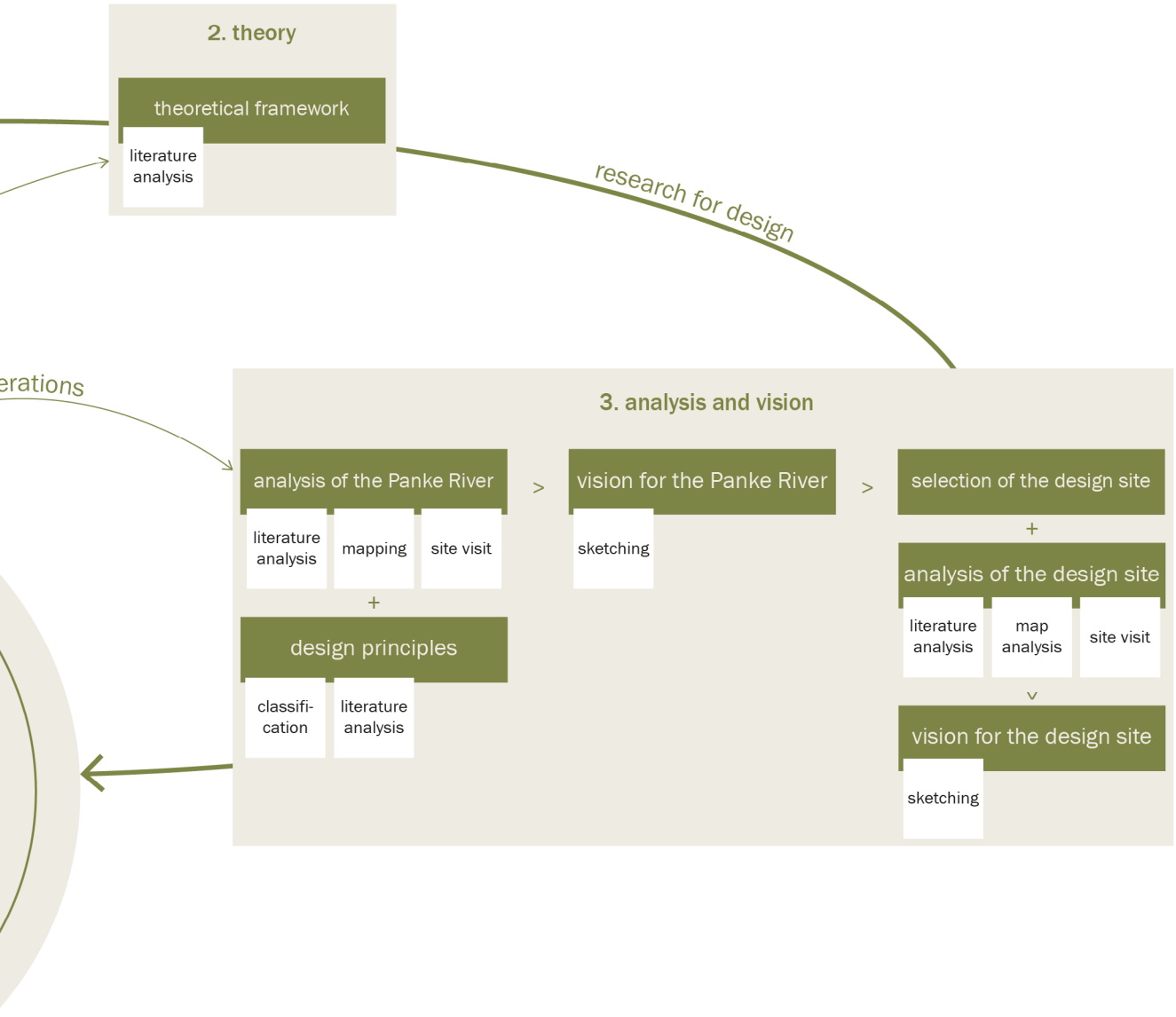


Figure 2.6. Research structure and methods


2. theory
theoretical framework
literature analysis
research for design
erations
3. analysis and vision
analysis of the Panke River
literature analysis
mapping
site visit
+
design principles
classifi-cation
literature analysis
>
vision for the Panke River
sketching
>
selection of the design site
+
analysis of the design site
literature analysis
map analysis
site visit
v
vision for the design site
sketching

Step one: Exploration

The first step is to get familiar with the topics of the graduation project: river ecosystems and environmental justice. Analysis of scientific literature, policy analysis, and mapping are methods to analyze the spatial characteristics of both topics in Berlin, the location of this graduation project.

Based on the first analysis, the problem statement can be formulated. The problem statement summarizes the problems that have been discovered in the analysis. It forms the basis for the research question. The research question is split up into subquestions, related to smaller steps of the graduation project.

Based on the initial analysis of Berlin, the Panke River is chosen as the research area.

Step one is addressed in Chapter 1, Introduction. It answers sub-questions 1 A en B.

Step two: Theory

The next step is formulating a theoretical framework. It defines the lens that is used to approach the research question. The first part of the theoretical framework introduces landscape ecology principles. It will be the basis of the design principles that will be used to improve the ecological value of the Panke River. The second part of the theoretical framework introduces the 3-30-300 design guideline for equitable green space access by Konijnendijk. This will be the basis of the design principles for improved environmental justice.

Step two is addressed in Chapter 2, Theory. This chapter answers sub-questions 2 A and B.

Step three: Analysis and vision

Now that a research area has been chosen, and the theoretical framework has been formed, the Panke River can be analyzed in more detail. The first step is an initial analysis. Then, the Panke River is analyzed based on the knowledge of the theoretical framework.

The next step is to formulate the design principles. These principles are based on the theoretical framework and the analysis of the Panke River. The design principles are the bridge between research and design and the guidelines during the design process. The next step is the vision for the Panke River. This is a spatial translation of the design principles. A smaller design site is selected to apply this vision in a detailed design. For this design site, the vision is made more specific.

Step three is addressed in Chapter 3 and 4. This chapter answers sub-questions 3 A and B and 4 A and B.

Step four: Design
As the 'research for design' phase is completed, the phase of 'research by design' can start. The design is a detailed elaboration of the vision. The design results in a range of products. These are the results of this graduation project. Among the products are a master plan, multiple sections (before-after and through time), eye-level visuals (before-after), and a phasing strategy.

Step four is addressed in Chapter 4, The Design of not just a Corridor. This chapter answers the main research question.

Step five: Reflecting
Finally, the main design results are summarized to answer the main research question. The reflection places the results in context.

Step five is addressed in Chapter 5, Conclusion and reflection.

This chapter discussed how the project develops in a linear direction. However, a design project is never a linear process. Every step forward leads to new considerations and questions, resulting in adjustments to the steps before. This cyclical process continues up until the very final stage of the process.

3 The Panke River: not just a corridor

Figure 3.1. Recreation on the bank of the Panke River (Wolter, 2016)

Figure 3.2. The modified water system of the Panke River

An introduction to the Panke River

Figure 3.3a. North of Berlin

Figure 3.3b. In the outskirts of Berlin

Figure 3.3c. Near the city center

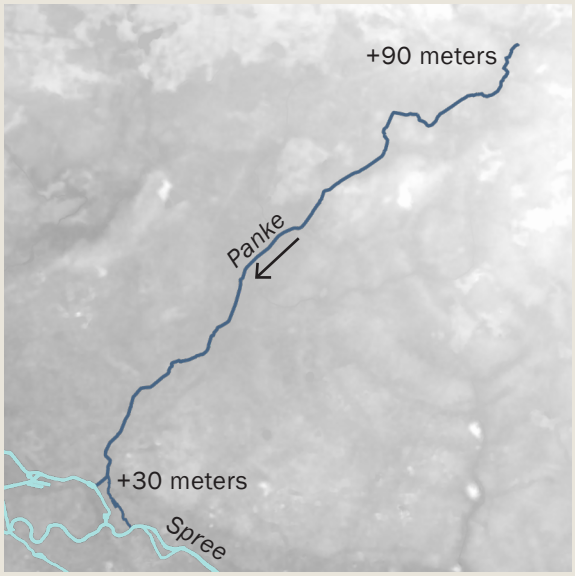
Water in the Panke River

The upstream part of the Panke River is groundwater-dominated. The source is located just north of the city of Bernau (figure 3.2). During summer, the river can dry out (Marx et al., 2021). Conversely, the downstream part of the river is rainwater-dominated. A large part of the urban area along the Panke has a sewage system that separates wastewater and stormwater. Stormwater is directly discharged into the river. A smaller part has a mixed system with stormwater overflows into the river. Another significant water source is a wastewater treatment plant (WWTP). The volume of water in the southern part of the Panke is regulated with weirs. WWTP discharge and stormwater discharge can be diverted into the Nordgraben canal (Marx et al., 2021). Nowadays, most of the water is redirected into the Berlin-Spandauer Schifffahrtskanal, at Nordhafen, and the final three kilometers of the original river course are mostly covered.

- water
- Panke
- tributaries of the Panke
- direction of flow
- weir
- catchment area
- green spaces
- green spaces connected to the Panke
- built

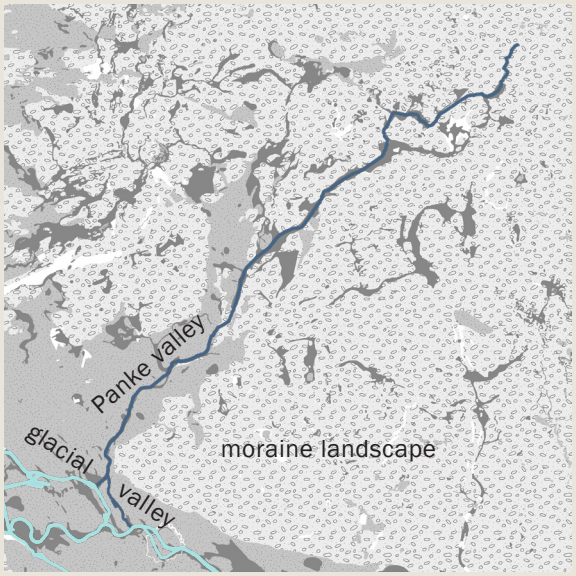
The landscape of the Panke River

The landscape of Berlin is shaped by the Weichselian glaciation. As the northern half of current-day Berlin was covered by a glacier, a parallel river valley was formed south of it. This valley stretches from Warsaw via Berlin to Hamburg. The Spree River follows the glacial valley across Berlin. The Panke River is a tributary of the Spree River and emerged as a meltwater river at the end of the Weichselian glaciation. The Panke is around 30 kilometers long, with a slope of around 2 percent between the source at 90 meters above



water
Panke
90 meters above sea level
30 meters above sea level

Figure 3.4. Elevation (data: Copernicus, 2016)



water
Panke
peat landscape
river landscape
moraine landscape

Figure 3.5. Geological landscape (data: Bundesanstalt für Geowissenschaften und Rohstoffe, 2007)

0 5 25 km

sea level and the mouth at 35 meters above sea level (Marx et al., 2021) (figure 3.4). Depressions in the landscape were transformed into peat landscapes (figure 3.5). From the 19th century onwards the sprawl of the city into the hinterlands accelerated (figure 3.6). Nowadays, the river runs through a predominantly urban area and flows into the River Spree near the city center of Berlin. Still, some natural and renaturalized green spaces are connected to the river (figure 3.7).

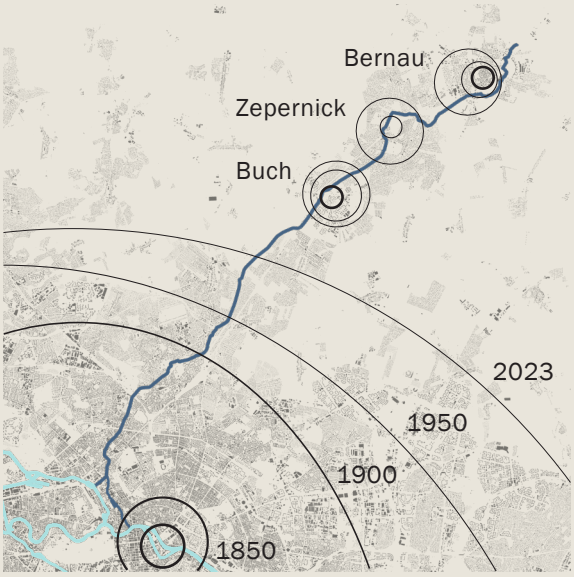


Figure 3.6. Urban expansion

Figure 3.7. Green spaces

N

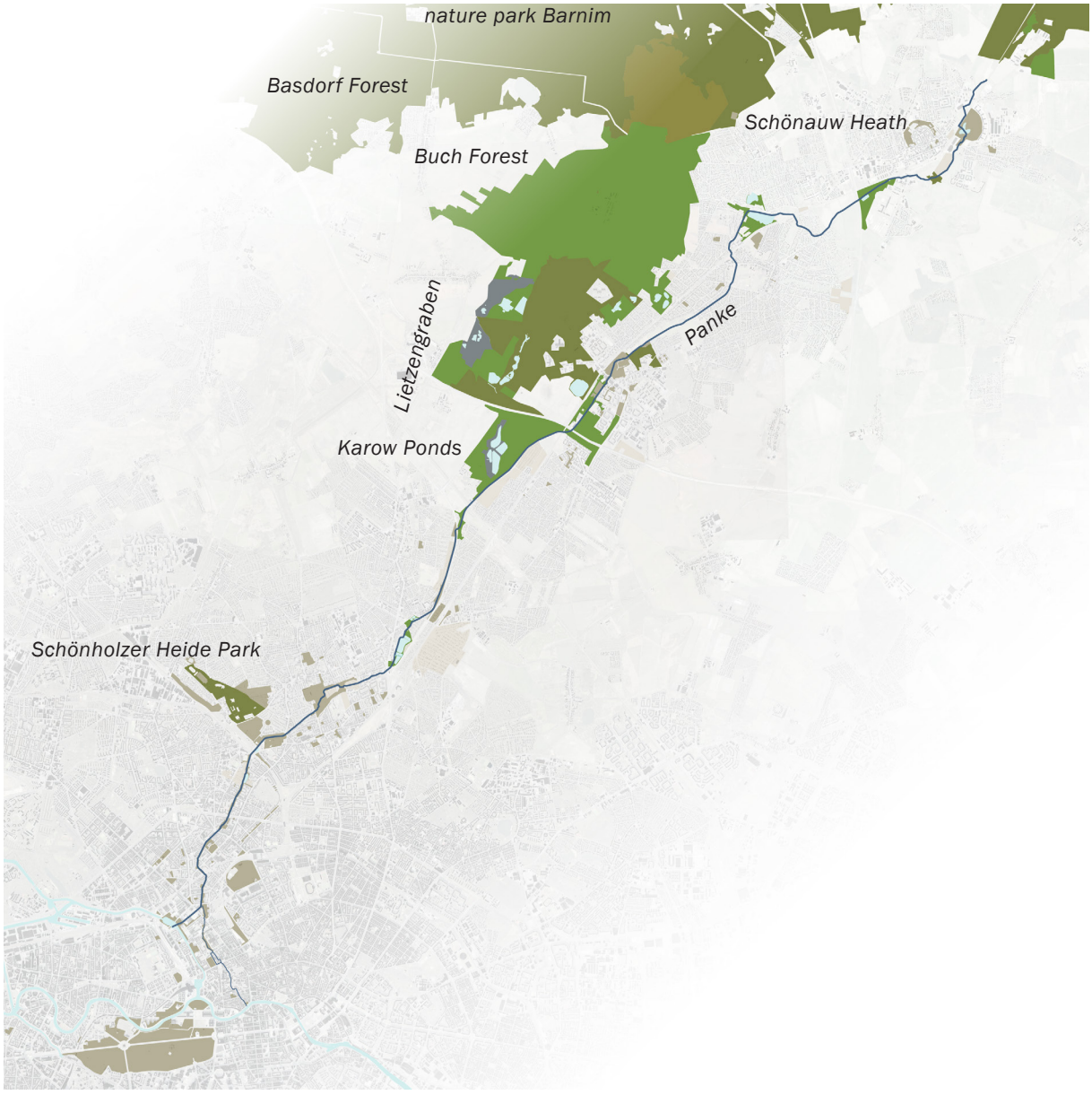


Figure 3.8. Different types of green spaces along the Panke River

The Panke River as an ecological corridor

The Panke River connects different natural greenspaces (figure 3.8). In the north, the tributary Lietzengraben connects the Panke with the Karow Ponds and the Buch Forest (figure 3.8). These are areas with wetlands, open fields, and wetlands. Located further upstream are Basdorf Forest and Schönow Heath. These areas are part of the nature park Barnim. In the urban areas, the Panke River connects with smaller parts of forested areas and semi-natural areas such as cemeteries and allotment gardens. The patch size is smaller and patches are fragmented.

As Dramstad et al. describe, (Chapter 2), width and connectivity are crucial components of an ecological corridor. Along the river, green spaces are fragmented, the width of the corridor is limited and vegetated riverbanks are lacking (figure 3.9).

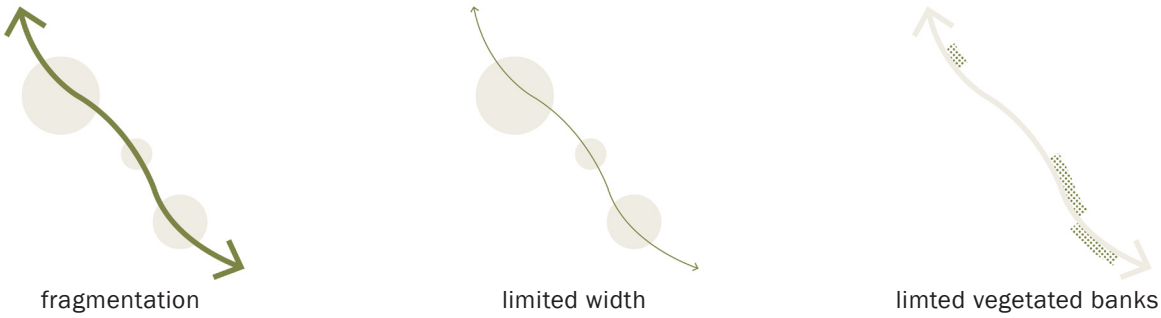
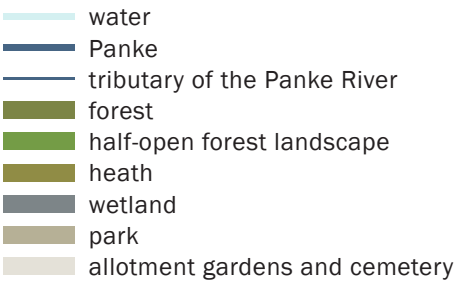


Figure 3.9. Limitations of the ecological corridor funtion of the Panke River



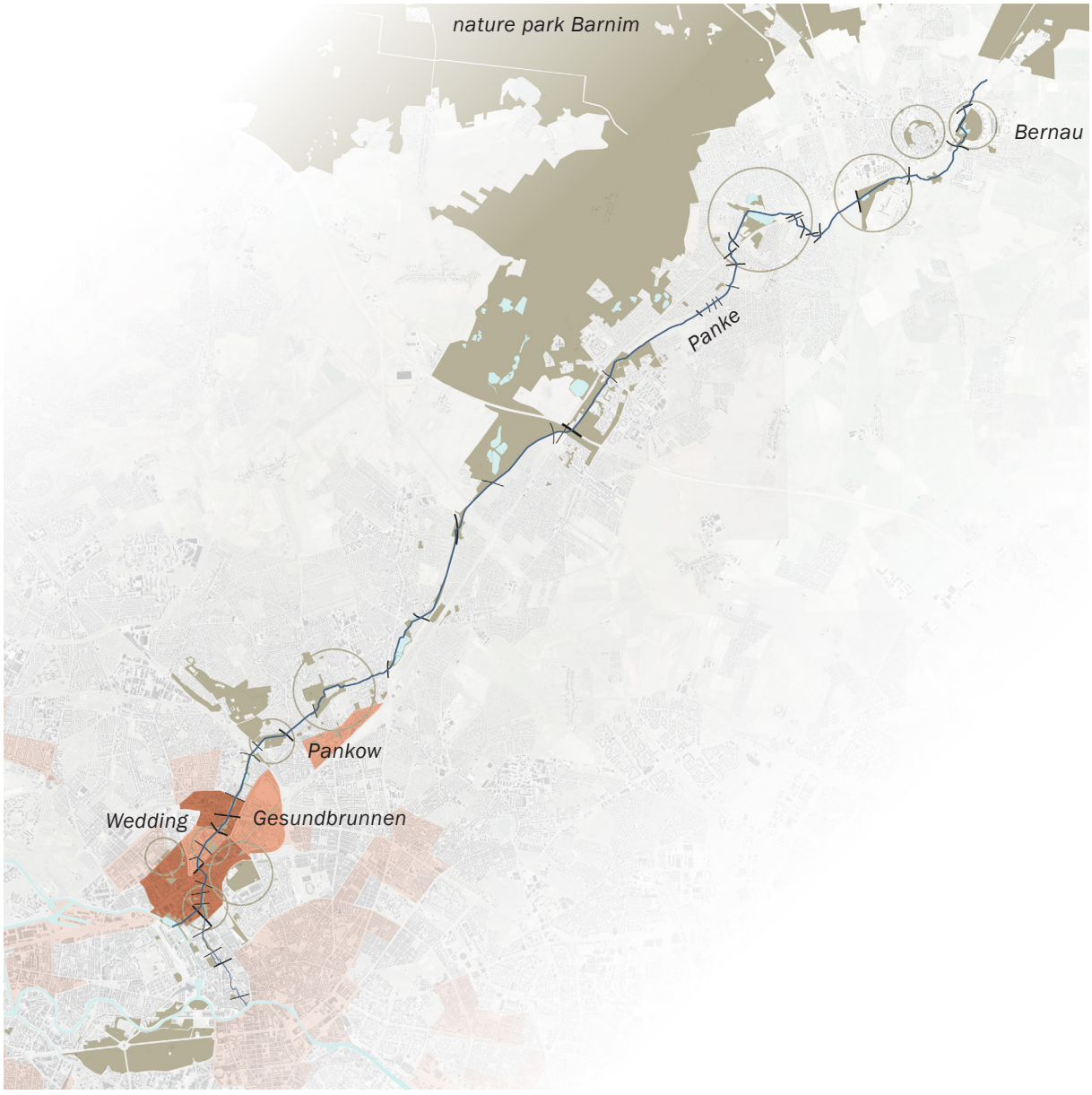


Figure 3.10. Access to greenspaces along the Panke River

The Panke River and access to green spaces

According to the 3-30-300 design guideline by Cecil Konijnendijk (Chapter 2), three factors are important for equitable access to the benefits of green spaces. As this research project focuses on the potential of the banks of the Panke River as green space, and not on making entire neighborhoods greener, the main concern of this analysis is the accessibility and availability of larger green spaces along the river.

Via the Panke River, the city connects with the nature park Barnim. However, both the availability and accessibility of large public green spaces are much lower in urban areas along the river (figures 3.10 and 3.11). Many urban areas are further than 300 meters away from larger green spaces. The Panke is a continuous linear element in the landscape. However, the greenspaces along the river do not connect. The fragmentation of greenspaces along the river inhibits the possibility of the river banks forming a well-connected public greenspace. Fragmentation limits the accessibility of larger natural greenspaces outside of the city via the banks of the river.

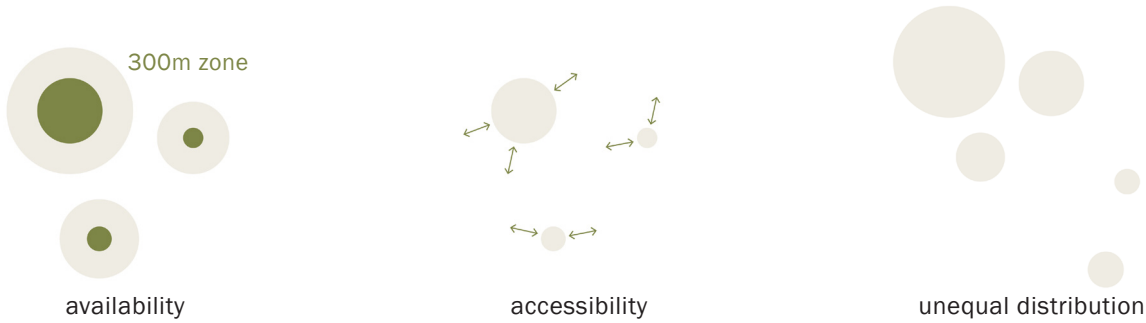


Figure 3.11. Limitations of equitable green space access

water
Panke
tributary of the Panke River
intersecting road
public greenspace
300-meter-zone around public green space
areas with the worst score on core indicators for environmental justice

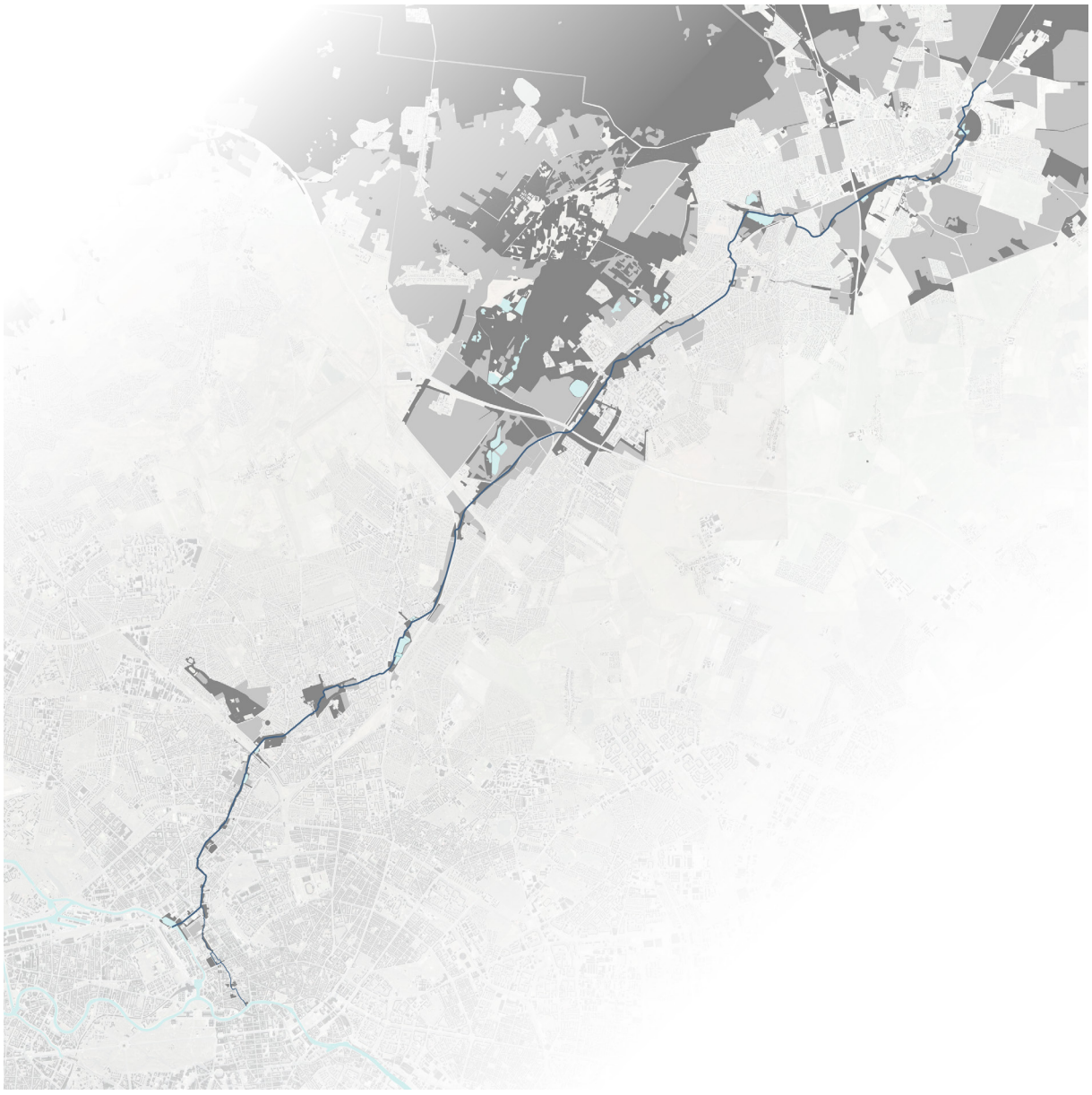


Figure 3.11. Open spaces connected to the Panke River

0 2 10 km

N

The open landscape

The urbanized context makes the renaturalization of the Panke River a challenge. Especially in Berlin, most land along the river is occupied by buildings and infrastructure, leaving limited open spaces (figure 3.11). This limits the potential of the river as an ecological corridor and the extent to which environmental justice can be mitigated. Nevertheless, the vision on page 66 shows that the situation can still be improved significantly within the limited available space. The following pages explain the ecological potential of the river.

water
Panke
tributary of the Panke River
nature reserve, forest, heath, scrubland, grass field, and park
cemetery, allotment gardens, meadow, and farmland

Design principles

The final result of this project will be a design. To be able to design based on the theory, a few steps have to be taken. First, design principles will be formed based on the theory and the characteristics of the location. Based on these principles, a vision is formulated for the Panke River. A small site is then selected to apply the vision in a design. This selected site is analyzed in more detail. A site-specific spatial vision is the last step before the design. This finalizes the 'research for design' phase. Afterward, the 'research by design' phase can start.

Target species

As mentioned in the theoretical framework, the effectiveness of specific design interventions is different for different species. To ensure the effectiveness of the Panke as an ecological corridor and habitat, it is needed to understand what species need. For this project, a limited number of species have been selected. There are multiple ways to select species for an urban design project. Often, it is not evident what species should be chosen (Apflebeck et al., 2019). Apfelbeck (2019) describes three ways to choose species.

1. Choosing a target species. Often chosen to preserve a particular species.
2. Choosing a habitat to preserve.
3. Choosing umbrella or indicator species. These species are often seen as representative of other species or a whole ecosystem.

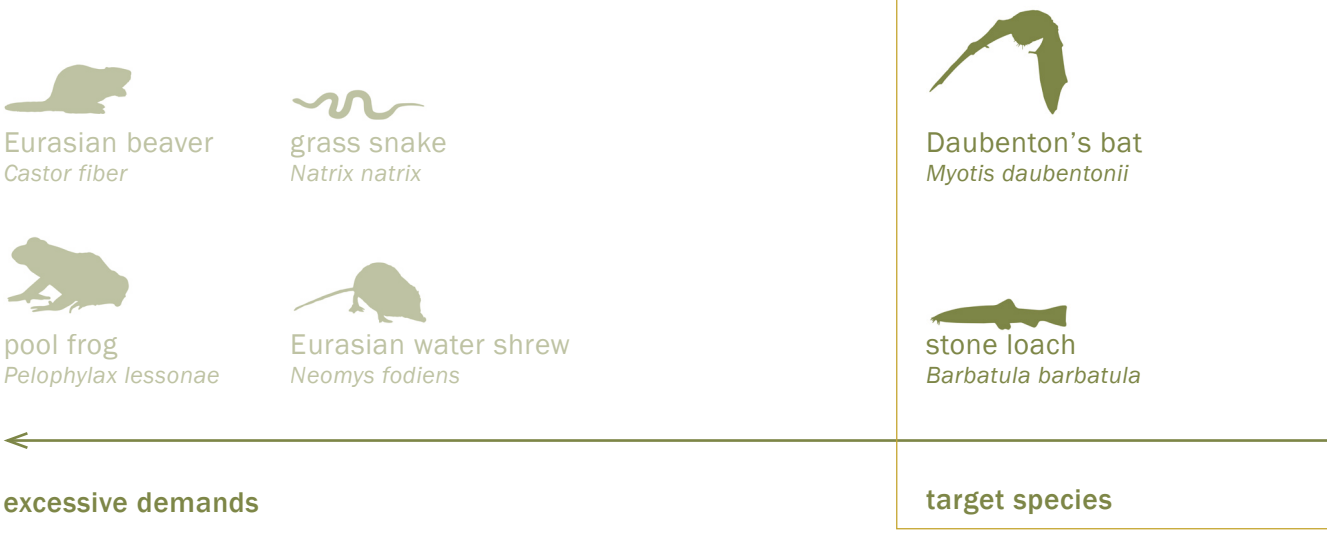


Figure 3.12. Selected target species

This project uses a combination of these approaches. Based on the habitat type - a slow-flowing river in the northwest European lowlands - a number of typical species can be selected. As the aim is to improve the complete ecosystem, it works best to make a varied selection of species.

Species with too demanding habitat and corridor requirements for this urban area have not been selected. It is far from realistic that the demands for species such as the grass snake, the water shrew, and the beaver can be met along the heavily urbanized Panke River. The water shrew, for example, needs key areas of at least five hectares, no more than two kilometers away from each other (Alterra, 2001). Far too little space is available to be able to meet these requirements. However, the Panke River can become a foraging area.

The species that have been selected (figure 3.12) do occasionally visit urban areas. The exact requirements for key area size and distance between key areas are unknown, but the use of the Panke River is realistic. Specific design interventions might result in more frequent use by these species. Other than species such as the hedgehog, blackbird, and heron, these species are not common generalist species in cities. The species are expected to visit the Panke River more frequently only if their requirements are met. The following paragraphs describe the selected species and their requirements.

common kingfisher
Alcedo atthis

banded demoiselle
Calopteryx splendens

common blackbird
Turdus merula

grey heron
Ardea cinerea

greylag goose
Anser anser

European hedgehog
Erinaceus europaeus

generalists

The natural ecosystem

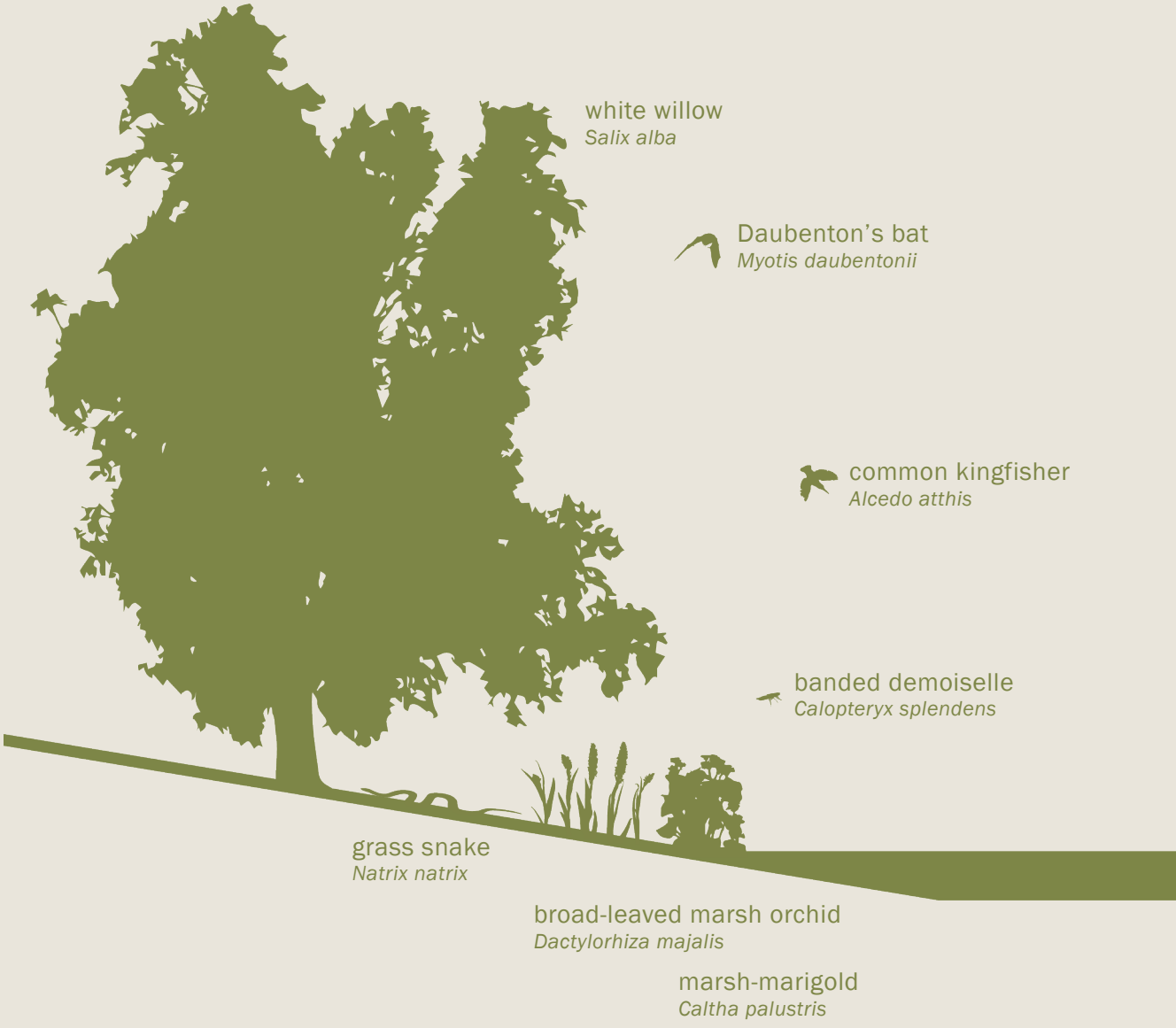


Figure 3.13. A selection of characteristic species of the natural ecosystem

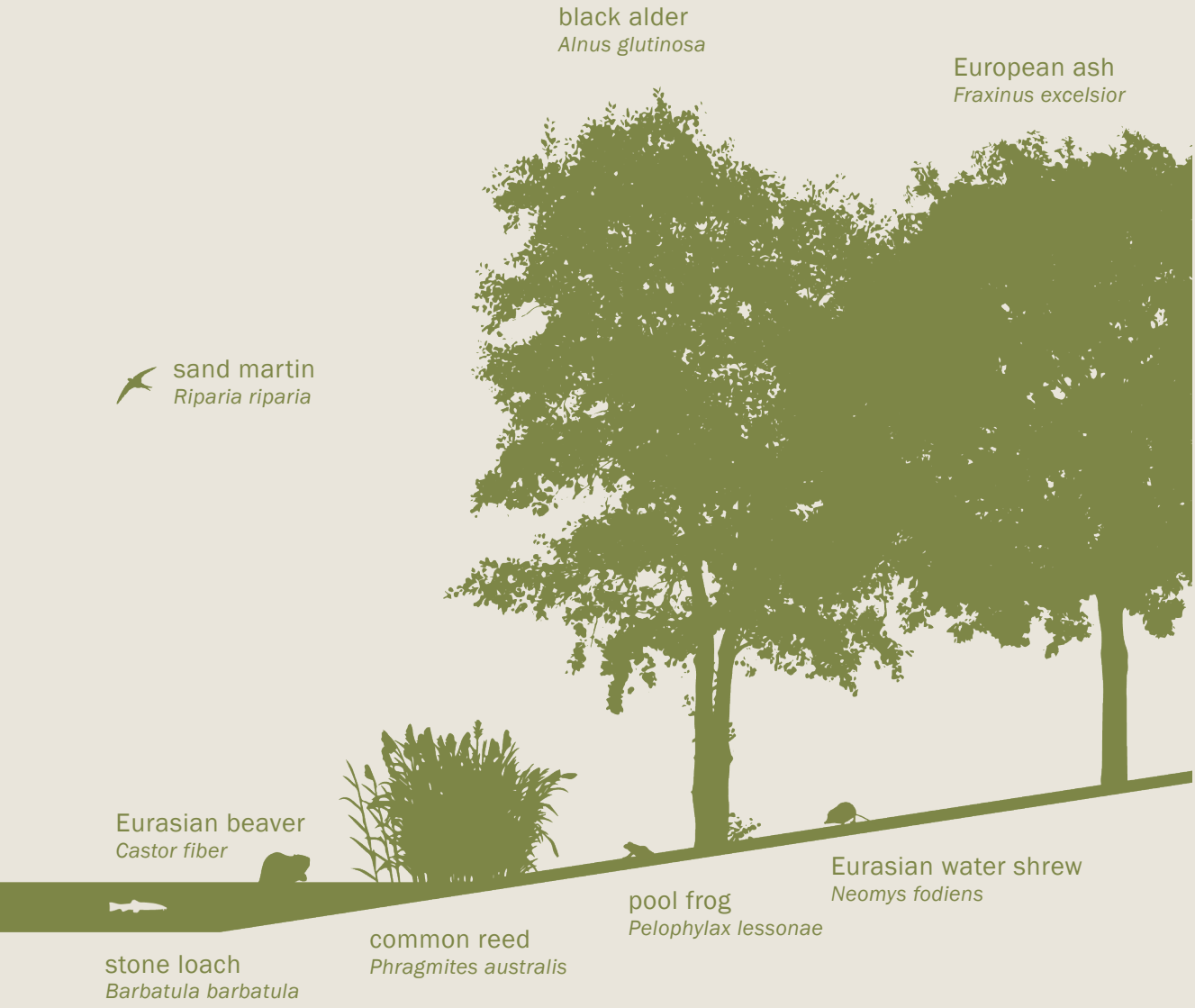

black alder
Alnus glutinosa
European ash
Fraxinus excelsior
sand martin
Riparia riparia
Eurasian beaver
Castor fiber
Eurasian water shrew
Neomys fodiens
pool frog
Pelophylax lessonae
common reed
Phragmites australis
stone loach
Barbatula barbatula

Figure 3.14. Daubenton's bat (Douma, n.d.)

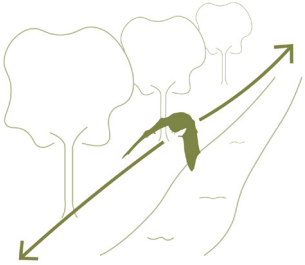


Figure 3.15a. Daubenton's bat uses linear landscape elements to navigate

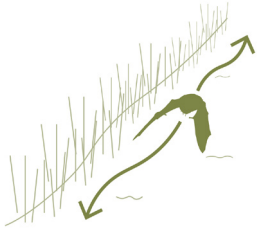


Figure 3.15b. Daubenton's bat hunts just above the water

Figure 3.16. Common kingfisher (Laats, 2017)

Figure 3.17a. The common kingfisher hunts along the water

Figure 3.17b. The common kingfisher makes breeding holes in steep riverbanks

Daubenton's bat - Myotis daubentonii

Daubenton's bat (figure 3.14) is four to six centimeters tall and has a span of around 25 centimeters. During the day in the active season, the bat hides in hollow trees, close to waterbodies. The species has also been found in bunkers, in old fortifications, in constructed bat shelters, and under bridges. After sunset, the bat flies along secluded waterbodies to hunt insects. Vegetated riverbanks provide water insects (figure 3.15b). The bat prefers half-open forest landscapes as a habitat, but it can also live in urban areas (BIJ12, 2017). It uses linear elements in the landscape, such as lines of trees, forest edges, and paths to navigate figure 3.15a). Gaps in these elements should not be too large. As the species is highly photosensitive, light pollution should be reduced near the places of stay and along the water (BIJ12, 2017).

Daubenton's bat has been observed on the western and eastern edges of Berlin (NABUa, n.d.). The city of Groningen in the Netherlands is an example of a municipality that has the ambition to increase the population of Deubenton's bat with design interventions. The planting of additional trees and shrubs along flight routes and the limitation of lighting are the main recommendations (Zoogdiervereniging, 2018).

Common kingfisher - Alcedo atthis

The common kingfisher (figure 3.16) is a bird species with bright blue and orange colors. The species, that primarily eats fish, is strongly related to water. Slow-flowing rivers and creeks are the main habitats. The occurrence of kingfishers demonstrates that water is of high quality (NABU, 2023). Common kingfishers hunt for fish and other water-bound animals (figure 3.17a). During the breeding season, the birds make breeding holes in steep riverbanks (figure 3.17b). Steep riverbanks can result from natural dynamics or be man-made (NABUb, n.d.). Breeding walls have to be at least around a meter in length along the river and should always be above the water level during the breeding season (Harder, 2017). According to Harder (2017), the ideal breeding wall is sheltered by vegetation on both sides. Constructing multiple breeding walls close to each other is preferred. They can be constructed with different types of sandy soil. Concrete elements are a low-maintenance alternative. The species can breed at a location with human disturbances, as long as a quiet place is available for the nests. A buffer zone of 50 meters between a nest and recreating people is advised (Krijgsveld et al, 2022).

The common kingfisher has occasionally been observed near the river Panke (NABU, n.d.). In Düsseldorf, the species is frequently observed in parks near the city center (NABU, 2021).

Figure 3.18. Banded demoiselle (Epperlein, 2022)

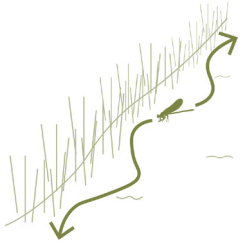


Figure 3.19a. Banded demoiselles hunt near the waterside

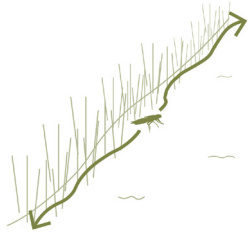


Figure 3.19b. Banded demoiselles larvae hunt in riverside vegetation

Figure 3.20. Stone loach (Herder, n.d.)

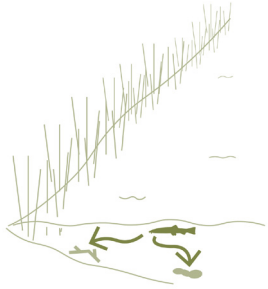


Figure 3.21a. The stone loach takes refuge behind plants and rocks

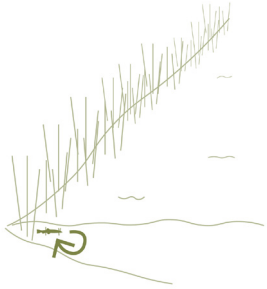


Figure 3.21b. Stone loach larvae take refuge between water plants

Banded demoiselle - Calopteryx splendens

The banded demoiselle (figure 3.18) is a dragonfly species with a length of around five centimeters. The males have a glossy blue color and the females are glossy green. This dragonfly species is threatened by water pollution and modifications of water courses. The banded demoiselle hunts for bugs in the vicinity of water (figure19a). The preferred habitat is a slow-flowing creek or river with plenty of riverbank vegetation. For most of the life span, the species lives as hunting larvae in the water (NABU Mecklenburg-Vorpommern, n.d.) (figure 3.19b).

The species has been observed along the Panke, in the urbanized areas of Pankow and Karow. According to the local government, the Panke River is one of the realistic locations in Berlin for the development of the species. Projects in East Germany have shown that the demoiselle can quickly colonize rivers if water quality is improved (Senatsverwaltung für Umwelt, Verkehr und Klimaschutz, 2020).

Stone loach - Barbatula barbatula

The stone loach (figure 3.20) is a brown-greyish fish species of up to 18 centimeters long. It is a common fish in creeks and mid-sized rivers in Germany. The stone loach hunts during the night. Insects and small water animals are on the menu (Deutschlands Natur, n.d.). During the day, the fish takes refuge behind stones, branches, and water plants (figure 3.21a). Water plants are also where eggs attach to and where larvae hide (Ravon, n.d.) (figure 3.21b). Fresh oxygen supply, for example from water plants and meanders, is a requirement. Improvement of the water quality and restoration of rivers and creeks can result in the recovery of stone loach populations (Ravon, n.d.). The species is tolerant to a relatively high degree of pollution (Deutschlands Natur, n.d.).

Nature-friendly riverbanks

The selected species have one thing in common. All four species benefit from renaturalized river banks. Different types of riverbanks can be distinguished (Stowa, 2009). Natural banks are the ones that have not been changed by humans. Cultural banks are fully dominated by humans. Nature-friendly banks are human-made banks that approach the natural situation (Stowa, 2009). The transition between water and land should be gentle. At least 1:1, but 1:3 or more is preferred (Van Breukelen et al., 2003).

Nature-friendly banks come in different types and have advantages and disadvantages (Stowa, 2009). In a very natural situation, a river can freely meander. Little maintenance is needed, as rivers maintain themselves. Natural meanders can only develop if sufficient space is available. Alternatives are side channels, forebanks, and ponds. These alternatives require more maintenance. A cheaper option is to create coves of nature-friendly banks along the river.

Design principles based on the 3-30-300 rule

Based on the theory of landscape ecology principles, the analysis of the river, and the requirements of the target species, the following design principles (figure 3.22) will be applied in the design to improve the ecological value of the Panke River:

1. Creation of more nature-friendly river banks.
2. Improvement of continuity of the riperian zone along the river.
3. Introduction of more renaturalized patches as habitats for the target species.

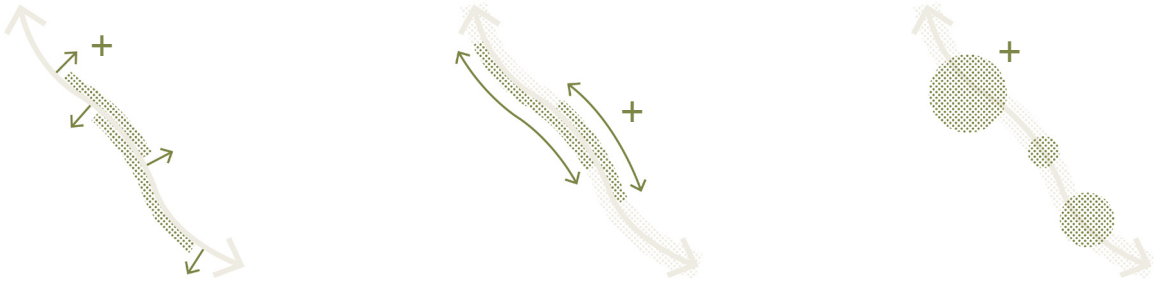


Figure 3.22. Design principles for improved ecological value of the Panke River

Design principles based on the 3-30-300 rule

The 3-30-300 rule is developed to help create greener, healthier, more resilient neighborhoods. To truly implement the rule, a design for a complete neighborhood would be needed. The Panke River is only a small element in the neighborhood. This design project focuses on the effect that redesigning the river banks can have on the accessibility and the quality of green spaces.

Research has shown that people rarely visit parks only for their natural qualities. More often, the reasons to visit parks relate to activities such as physical activity, relaxing, and meeting people. However, people enjoy interactions with the natural surroundings in parks. The diversity of structure, vegetation, and materials in parks attracts more users to parks (Vierikko et al., 2020).

To improve the accessibility and quality of green spaces along the Panke River, the following principles (figure 3.23) will be applied in the design:

1. Connection of separate green spaces as one park.
2. Enhancement of the connection with the neighborhood.
3. Diversification of the structure to support a larger range of recreational activities.

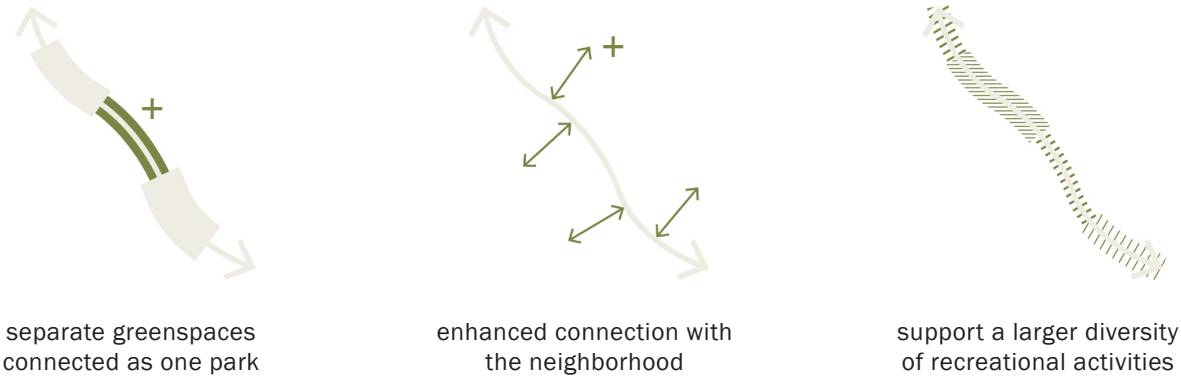


Figure 3.23. Design principles for improved accessibility and quality of green spaces along the Panke River

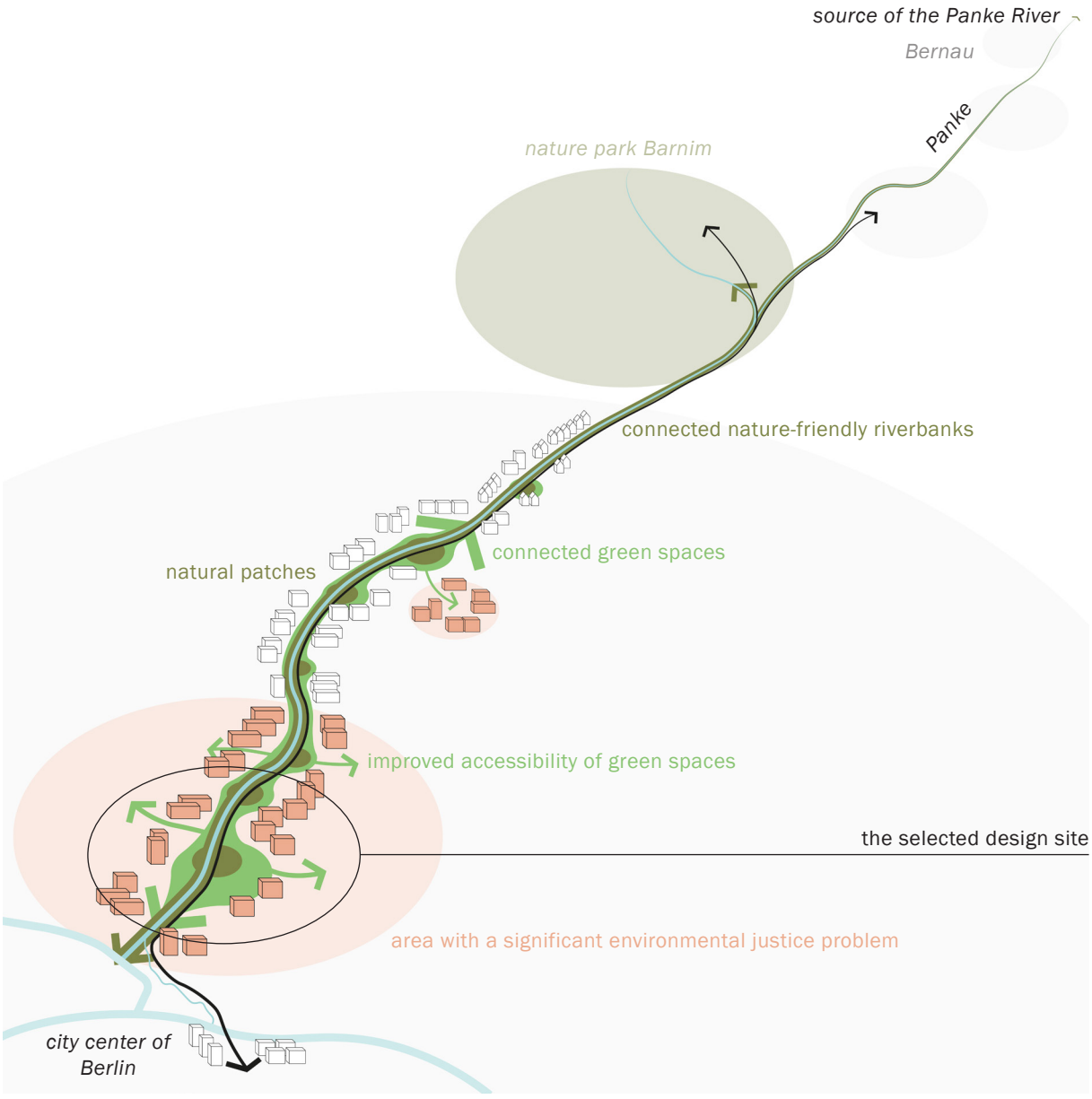


Figure 3.24. Schematic version of the vision for the Panke River

Vision: not just a corridor

The analysis of the Panke River reveals how its ecological value and equitable green space access are limited. Fragmentation, limited width, and a low share of vegetated riverbanks have a negative impact on the ecological value of the river. Access to green spaces is insufficient due to too little availability, poor accessibility, and unequal distribution. The aim of this graduation project is to optimize conditions for both the natural ecosystem and environmental justice. To achieve this, the theory-based design principles are combined in a vision for the Panke River.

Both the natural ecosystem and humans benefit from improved connections between the existing green spaces along the Panke River. A continuous natural riverbank allows the target species to move along the river. Where sufficient space is available, the target species will have new habitats in constructed natural patches. Residents of northern Berlin benefit from an improved walking and cycling route along the Panke that makes the natural green spaces outside of the city more accessible. The fragmented green spaces in the neighborhoods with the most significant environmental justice problem are connected and upgraded to improve equitable green space access. The connected fragments of green spaces will form a large vibrant park structure, as a backbone of these neighborhoods, where humans and the natural ecosystem coexist.

Figure 3.24 is a schematic representation of this vision. Figures 3.25 and 3.26 show how this vision is converted to the landscape.

The design site

The final part of this design project focuses on a selected design site in the district of Gesundbrunnen, an area with a significant environmental justice problem. Substantial improvements are required along this segment of the river. This segment of the river requires substantial improvements, but the context of a dense urban area makes it challenging to apply the vision for the Panke River. The design site is introduced from 72 onwards.

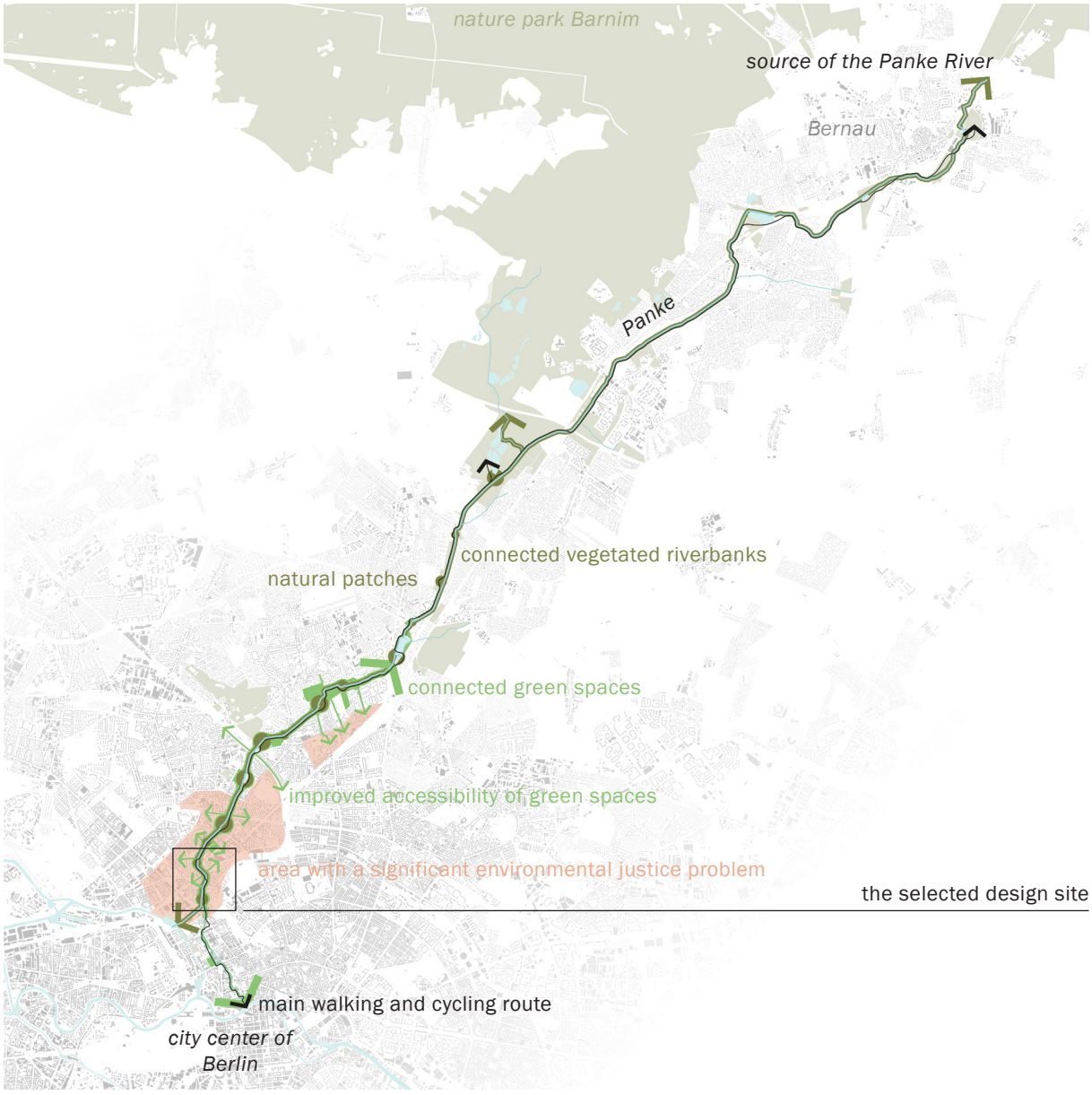


Figure 3.25. Vision for the Panke River

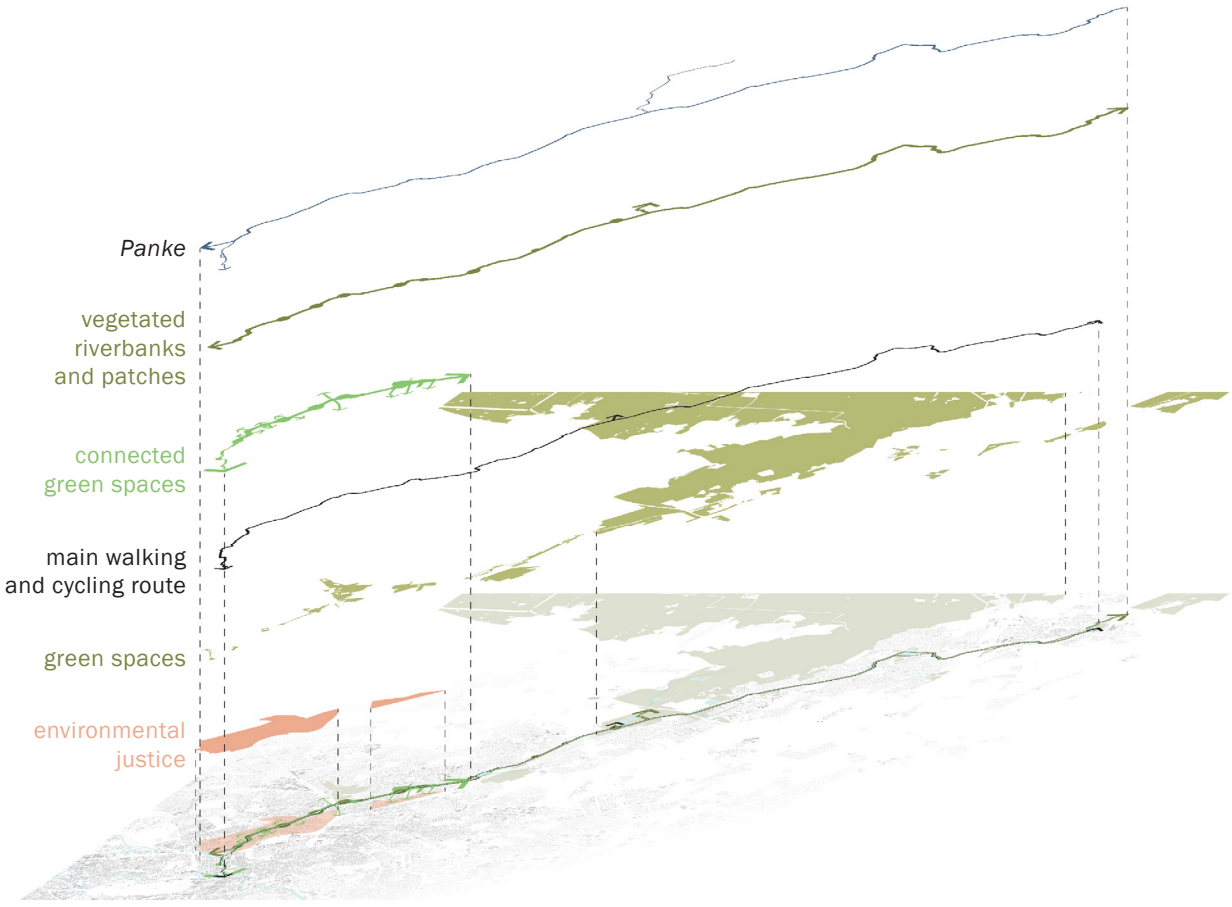


Figure 3.26. Layers of the vision for the Panke River

water
Panke River
main route along the Panke River
green spaces connected to the Panke River
vegetated river banks and renaturalized patches
connected green spaces
areas with the worst score on core indicators for environmental justice

4 The design of not just a corridor

Figure 4.1. Satellite image of the disign site (ESRI, 2023a)

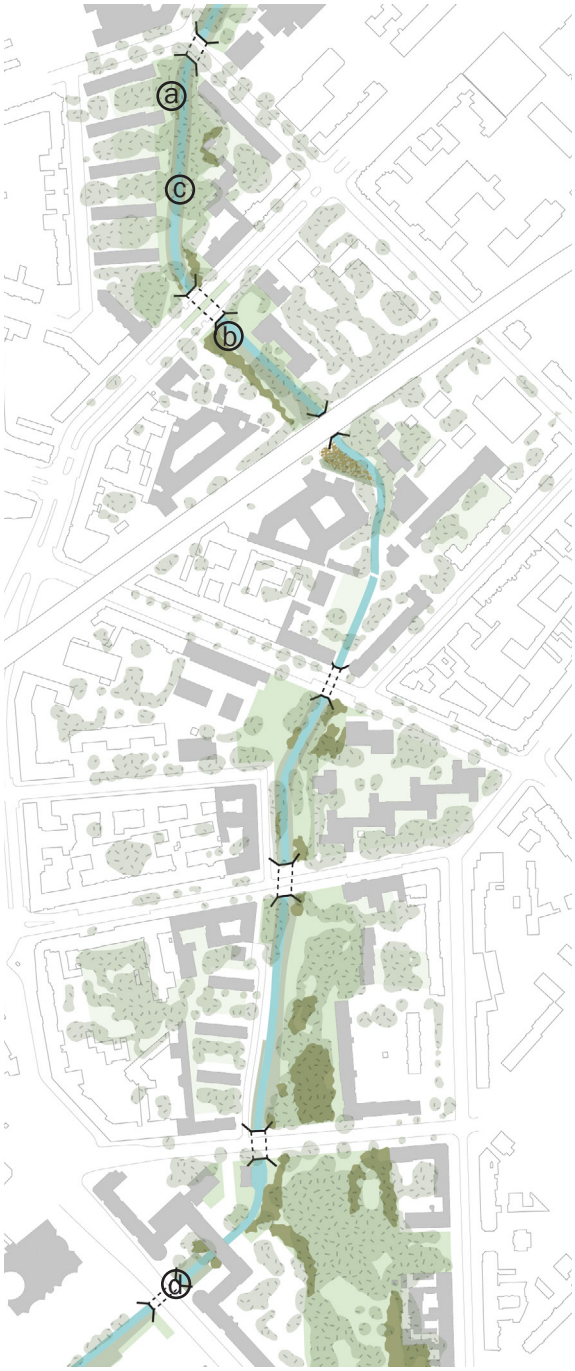
Figure 4.3a. Bridge

Figure 4.3b. Prunus serrulata 'Kanzan' (foreground) and Acer platanoides (background) (Pharus, n.d.)

Figure 4.3c. Courtyard

Figure 4.3d. Building above the water

Analysis of the urban habitat



The River Panke in Berlin is a different habitat than the river in the countryside. The course of the river is extremely modified at the design location. The river profile is made narrower, the banks have been reinforced with concrete walls, a large number of bridges cross the river, and the landscape along the river is urbanized. Figure 4.2 shows the different elements of the urban habitat. Some of these elements are shown in figures 4.3a-d.

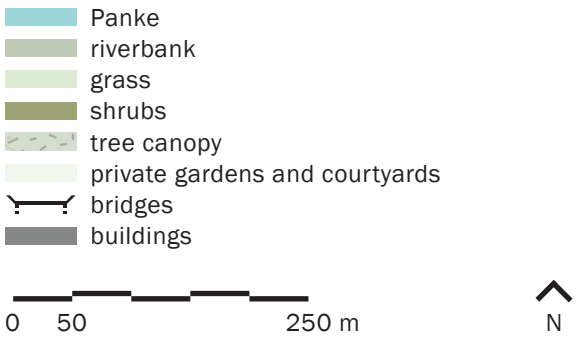


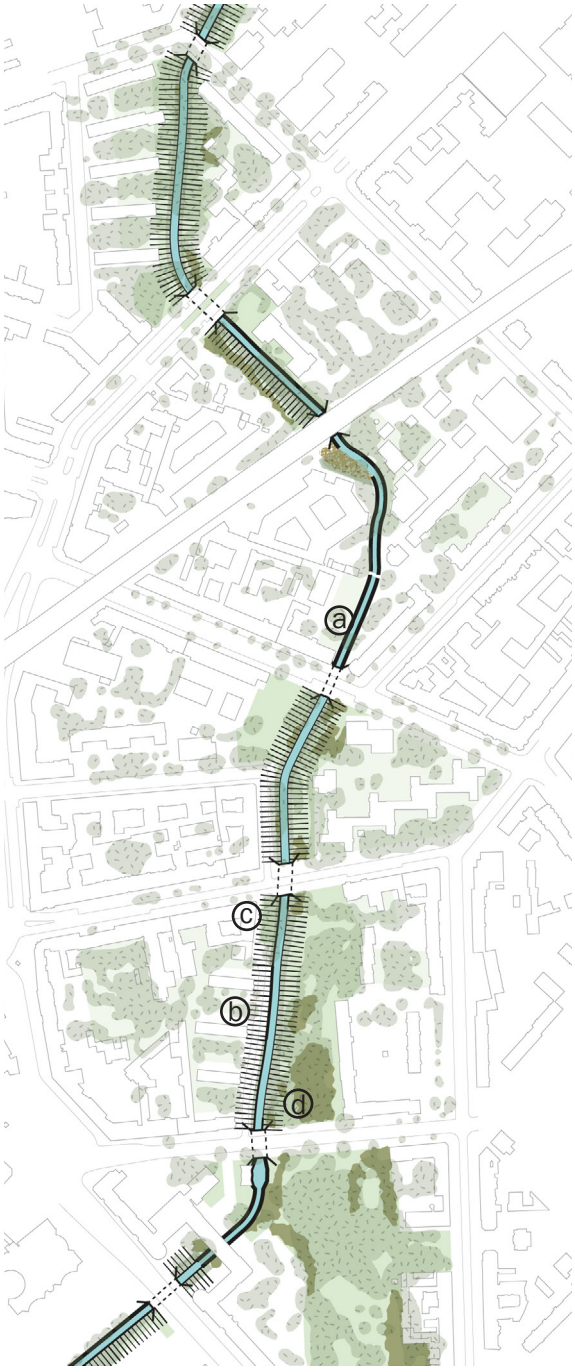
Figure 4.2. Urban habitats

Figure 4.5a. High wall

Figure 4.5b. Wall with stone bank

Figure 4.5c. Medium high with vegetated bank

Figure 4.5d. Low wall with vegetated bank



Riverbank typologies

The riverbanks are different in height, slope, and material. In general, there are 4 typologies at the design site (figure 4.4). High walls (figure 4.5a), walls with a stone bank (figure 4.5b), medium high walls with vegetated riverbanks (figure 4.5c), and low walls with vegetated banks (figure 4.5d). All typologies lack a riparian zone, the gradual transition between land and water. The lower a wall is, the easier it is to transform it into a nature-friendly riverbank.

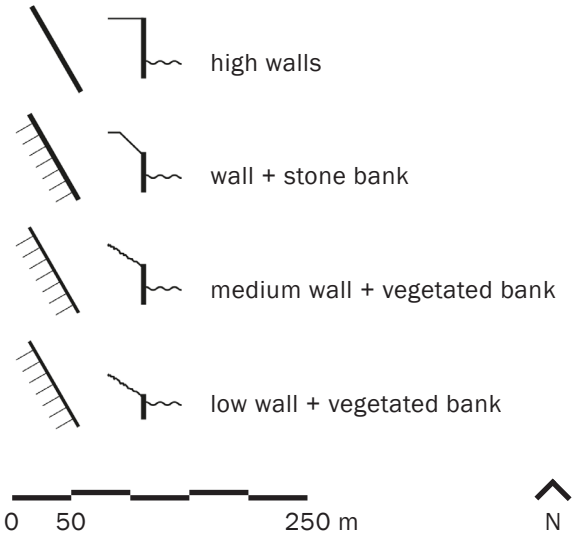


Figure 4.4. Riverbank typologies

Figure 4.7a. Playground Schönwalder Straße (Woll, 2018)

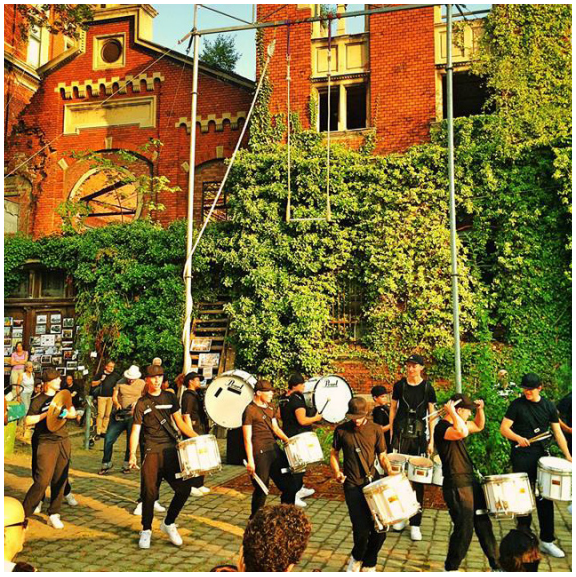


Figure 4.7b. Event at Wiesenburg (Wiesenburg, 2016)

Figure 4.7c. Pop-up bar next to the Panke River (Laucius, 2021)

Figure 4.7d. Activity at the Südpankepark (F. A.-St., 2019)

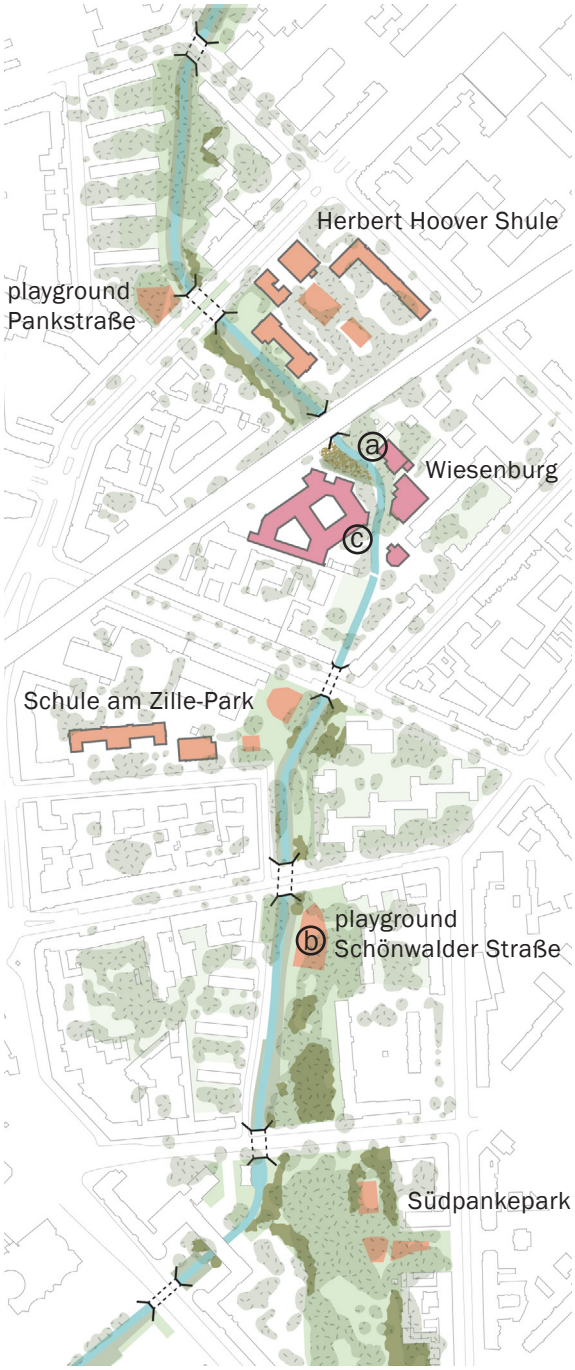


Figure 4.6. Human disturbances

Landuse

It is relevant to consider human disturbances when selecting areas to create natural patches (figure 4.6). Children might disturb animals around schools and playgrounds (figure 4.7a). The 'cultural center' around the Wiesenburg in Berlin offers a large range of recreational activities, such as art exhibitions, music performances (figure 4.7b), pop-up teraces (figure 4.7c) and a discotheque. Südpankepark is a city park where groups of people gather (figure 4.7d). Areas with natural dynamics should be located at some distance from these disturbances.

Figure 4.9a. Intersecting road

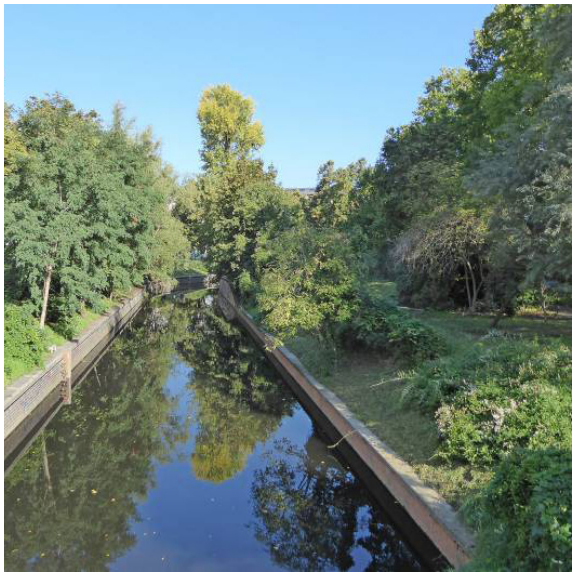
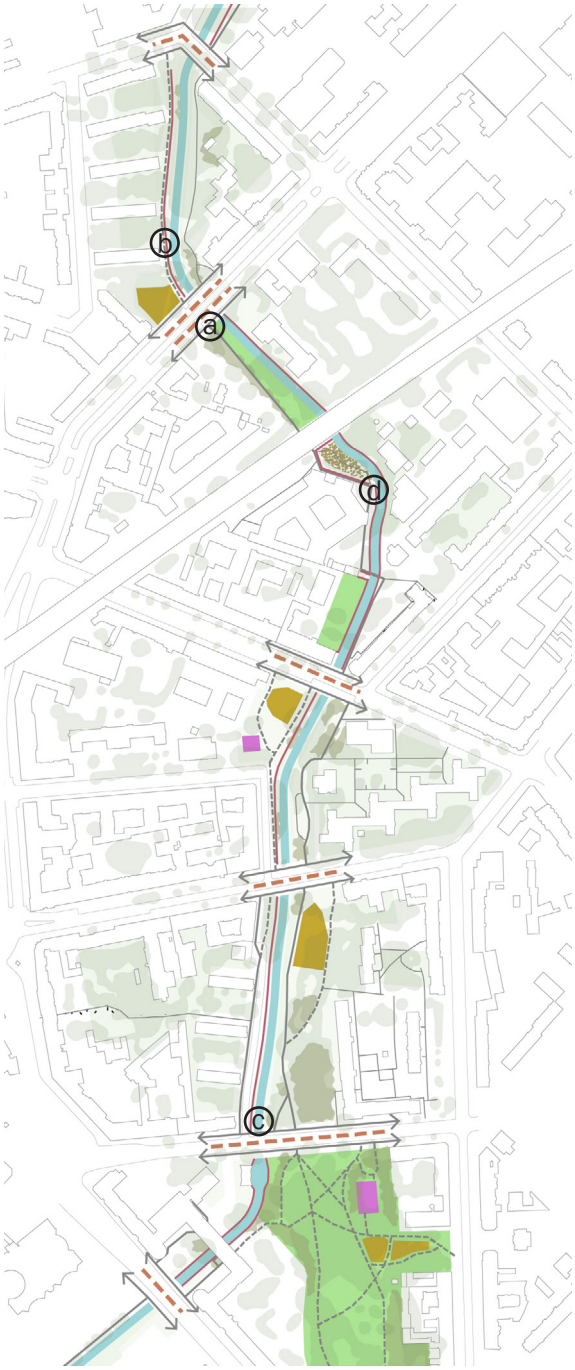


Figure 4.9b. Shrubs on the riverbank (Pharus, 2010)

Figure 4.9c. Gravel path and wall

Figure 4.9d. Recreation next by the Panke River (Zöllner, 2020)

Analysis of green space quality



The quality of the riverbanks as green space for residents is limited by a number of factors (figure 4.8). The large number of intersecting wide roads leads to the fragmentation of green spaces (figure 4.9a). A large share of the green spaces is not designed or managed to allow recreational activities (figure 4.9b). Paths are often of poor quality or poorly maintained (figure 4.9c). Waterside recreation is possible at a only few grass fields along the river. Poeple often recreate in areas that are not designed with that purpose (figure 4.9d). Restaurants and kiosks are completely absent. There are only a few sports fields. Playgrounds are widely available but aimed at young children only.

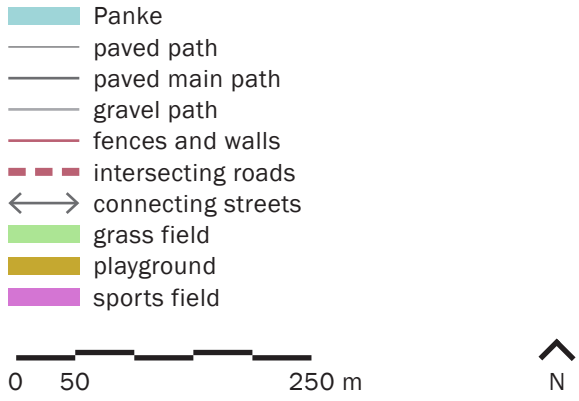


Figure 4.8. Recreation qualities and limitations

Historical development

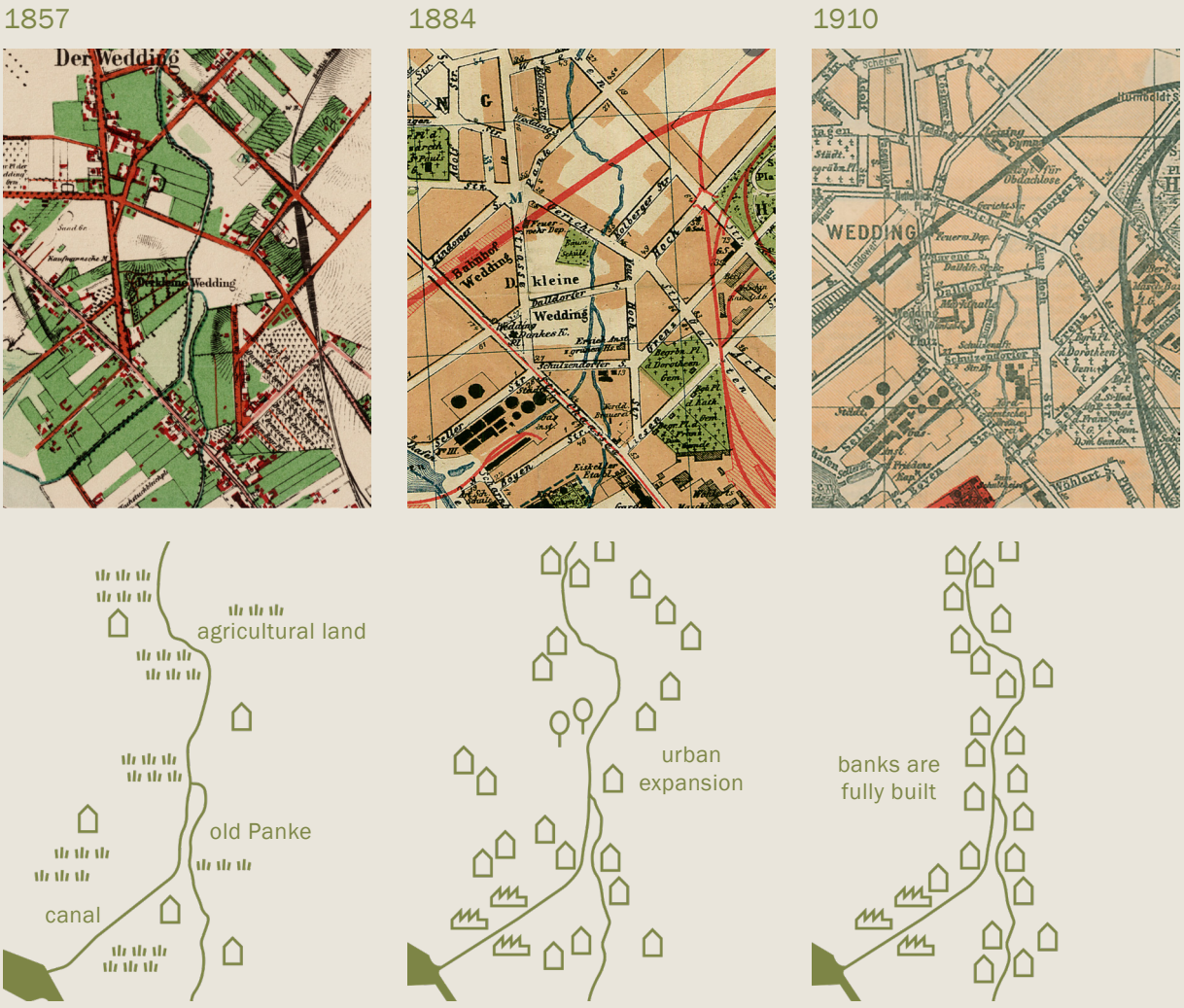
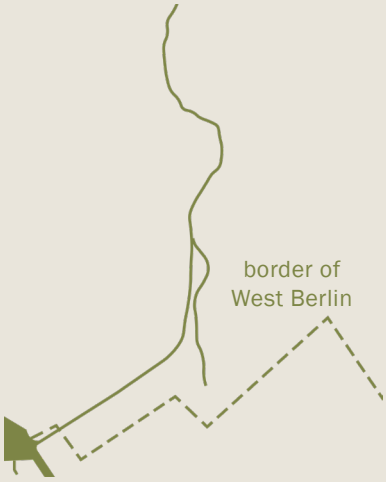


Figure 4.10. Historical development of the Panke River and the adjacent districts Gesundbrunnen and

1959

1986

2023



N

Wedding (maps of 1857, 1884, 1910, 1959, 1986: Müller, n.d.; map of 2023: ERSI, 2023b)


dynamic nature
recreation in nature
cultural venue
recreation in nature
dynamic nature
city park
uncovered
river branch

Design vision

The aim is to enhance the ecological value of the river while also improving the accessibility, availability, and quality of green spaces at the design site. The vision (figure 4.11 and 4.12) is to create an alternation of green space types. The city park and cultural venues will remain, and activities that may disturb the natural ecosystem will be concentrated there. The dynamic natural patches, which are the habitats of the target species, are located at a distance from the city park and cultural venues to minimize human disturbances. The gradual transition between the intensive recreational areas and the natural patches is formed by areas of recreation in nature. Nowadays, these areas are of low recreational and ecological value. A transformation into a recreation landscape with half-open vegetation allows residents to walk, stay, and play along river banks and in the water.

The different green spaces are connected with a continuous walking and cycling route, with cyclists and pedestrians having priority at intersections with streets. Where streets cross the park, they are made narrower to minimize the fragmentation of green spaces. Concrete riverbanks are transformed into vegetated ones wherever possible, and vegetation is continued on street intersections and under bridges. Additional green connections to improve the accessibility of the park for residents of the surrounding neighborhood.

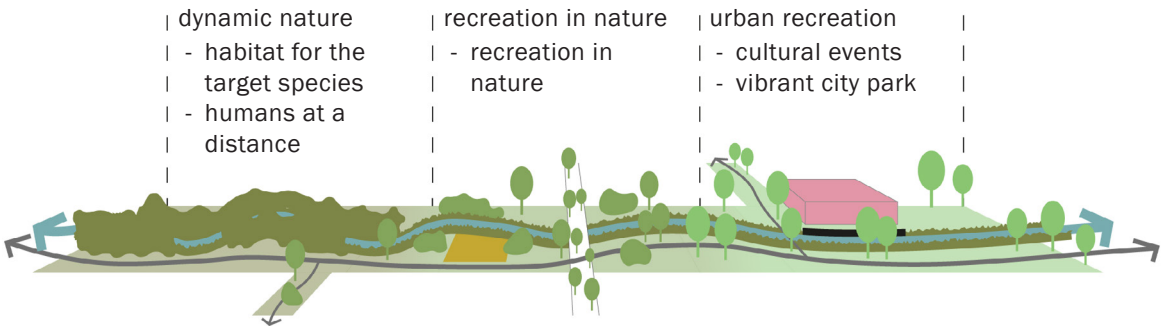


Figure 4.12. Schematic version of the vision for the design site

Figure 4.11. Vision for the design site


nature-friendly riverbanks
improved connection of fragments
recreation in nature
natural dynamics in the city

Masterplan

The masterplan shows the design based on the vision of an alternation of more natural and more recreational areas. The following pages explain the design by means of visuals and sections for four locations.

Natural dynamics in the city (page 86-89)
Natural dynamics take over at the first location. To minimize disturbances, humans experience this natural area from a distance.

Nature-frindly riverbanks (page 90-93)
Natural dynamics can not take over everywhere. The profile of the river is often too narrow. Still, natural dynamics can be introduced. Here, humans can experience nature from closer by.

Recreation in nature (page 94-97)
The human user is put first here. A transformation of the river banks allows for a large range of recreational activities while allowing animals to move across.

Improved connection of fragments (page 98-101)
Bridges and crossing roads are major obstacles for both humans and animals. Continued vegetation and safe priority crossings minimize the physical and visual fragmenting effect that roads have.

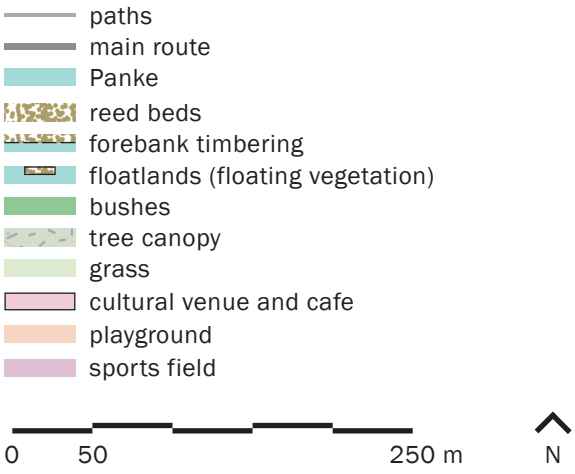


Figure 4.13. Masterplan

Natural dynamics in the city

Figure 4.14. Design impression

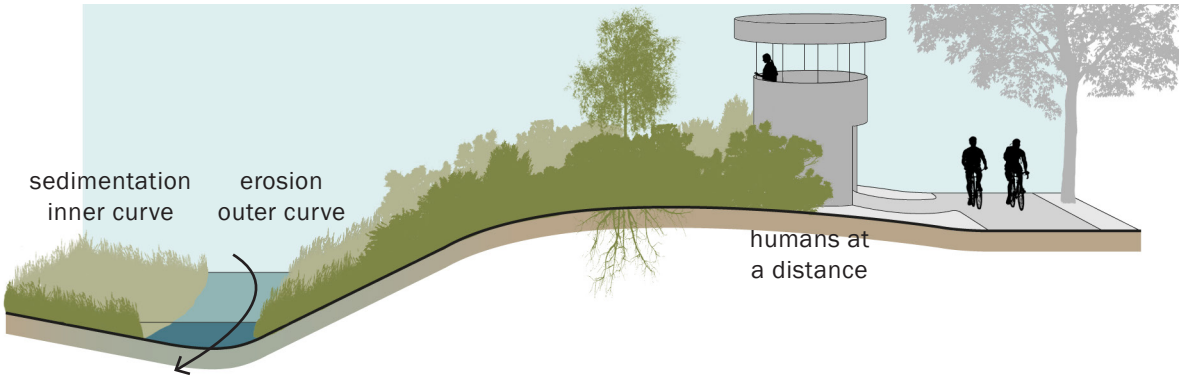


Figure 4.15a. A new course is dug and concrete walls have been removed. Humans keep their distance

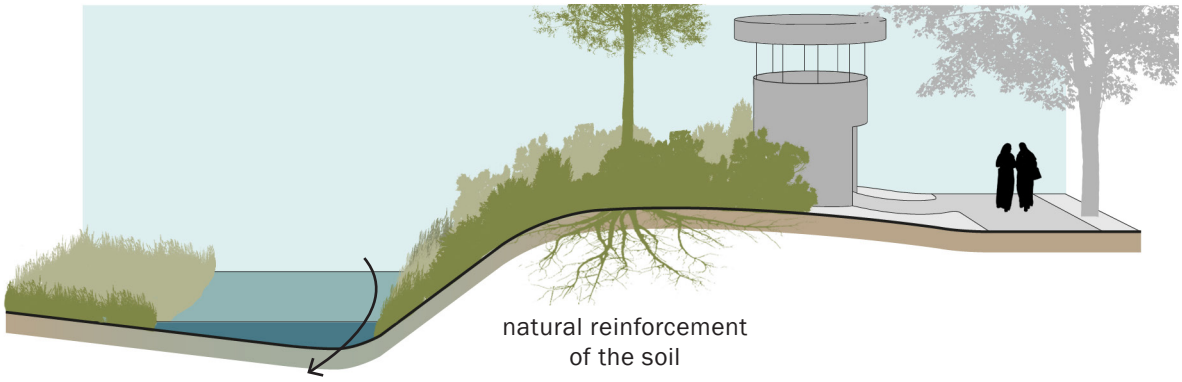


Figure 4.15b. The outer curve of the river erodes, the inner curve becomes more gentle

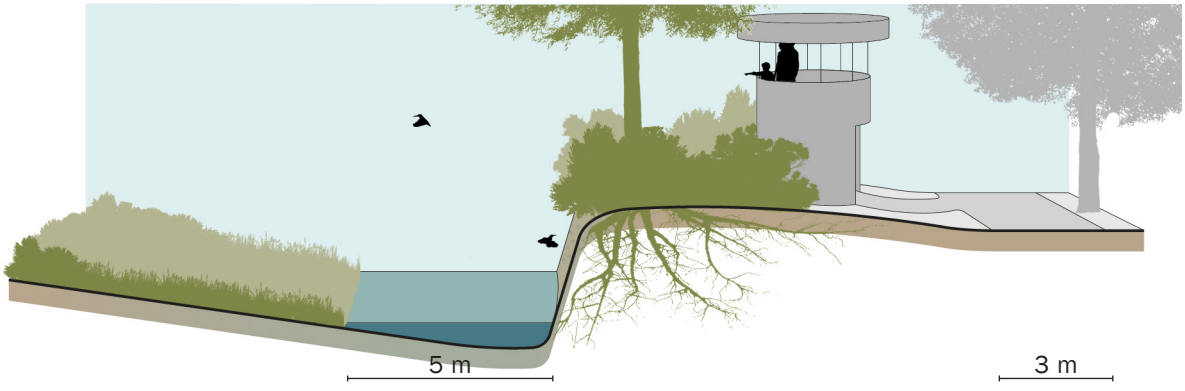


Figure 4.15c. After a while, erosion creates steep riverbanks that the kingfisher uses as nesting place

Figure 4.16. Location of visual and section

Dynamic development over time
Where the space is available, the river is given a wide profile where all concrete walls and timbering are removed. Within this wide profile, natural dynamics will take over the site. A dug river course will transform into a meandering system with steep riverbanks and gentle slopes. As human disturbance is limited, the target species can find a natural habitat here. Dabenton's bats can hide in old trees and kingfishers can make breeding holes in steep riverbanks. Some management at specific locations should take place to create vistas for people.

Figure 4.17. Current situation (Google, 2018)

Nature-friendly river banks

Figure 4.18. Design impression

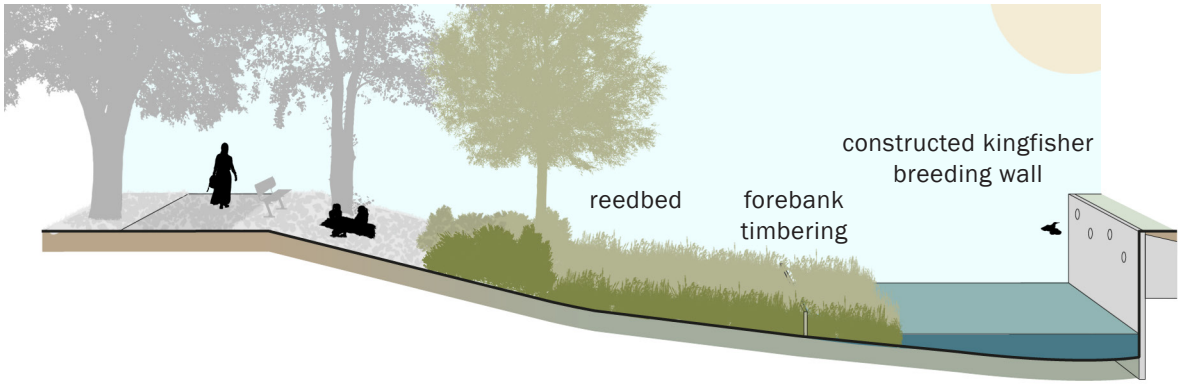


Figure 4.19a. A wooden forebank construction keeps the river course in place.

Figure 4.19b. The reedbed dries out when the water level is low

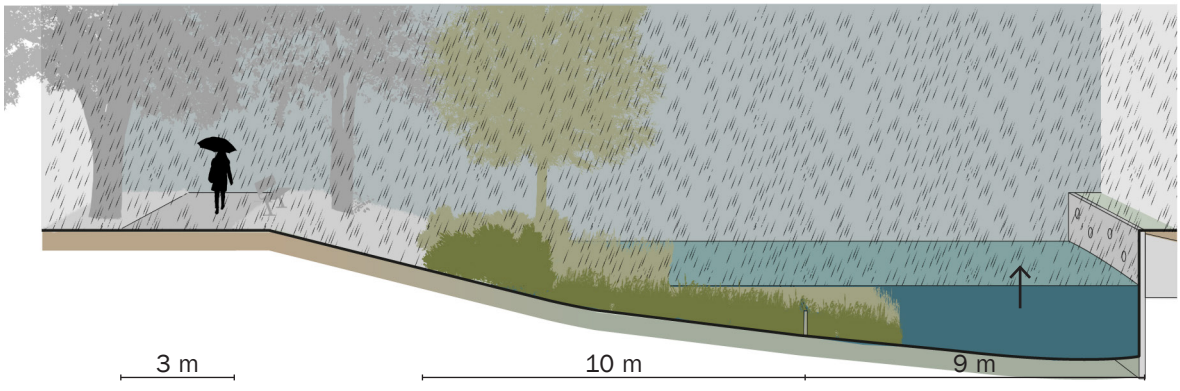


Figure 4.19c. The reedbed is flooded as the water level has risen to an unusually hight

Figure 4.20. Location of visual and section

Dynamics within a constructed river
The river can not be renaturalized completely where space is limited. But even a narrower profile can allow more dynamics. Meanders can also be constructed. By replacing a concrete wall with a wooden forebank protection, the course of the river is still controlled while allowing a reedbed to develop. The gentle slope allows the dynamic water level to have an effect on the vegetation. Artificial breeding walls and bat shelters further improve the ecological potential.

Figure 4.21. Winter 2023

Recreation in nature

Figure 4.22. Design impression

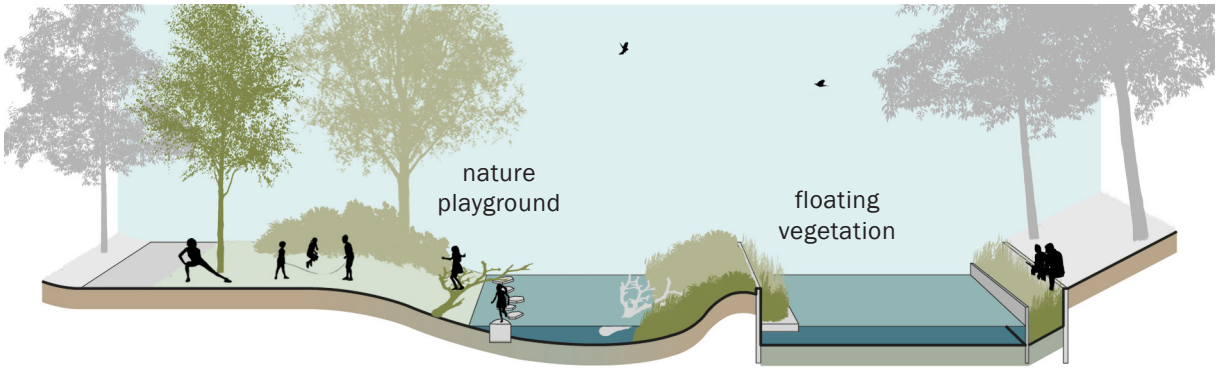


Figure 4.23a. The closeable side channel is playground and a leisure area

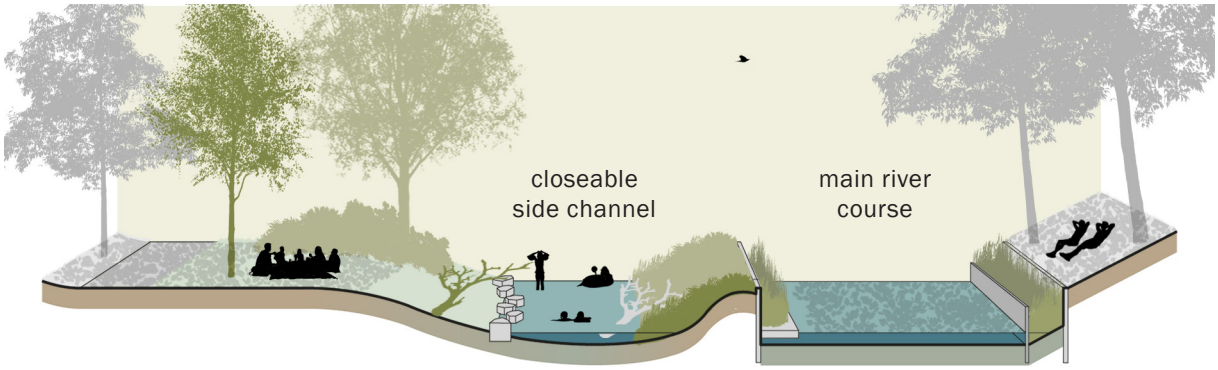


Figure 4.23b. Refreshment on a hot summer's day

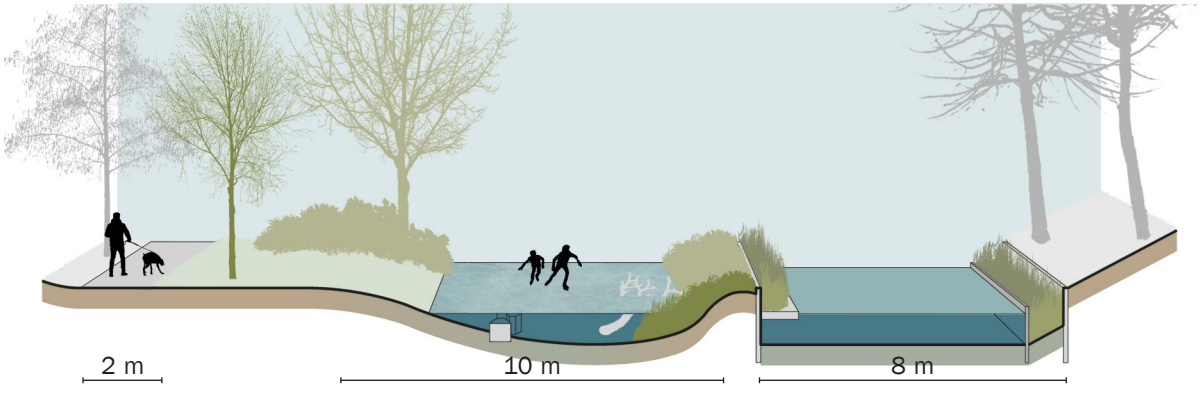


Figure 4.23c.Ice skating during winter

Figure 4.24. Location of visual and section

Use throughout the year

The spatial quality of the river is improved for people as well. One of the areas is this natural playground. More gentle river banks allow recreation on the riverbanks. A closable side channel, separated from the main river course, allows children to safely play next to and in the water. The area provides refreshment in summer and allows for ice skating during winter. Floatlands - floating vegetation - and small reedbeds are a cheap and simple way to establish a continuous vegetated riverbank that allows the movement of species where space is limited.

Figure 4.25. Winter 2023

Connection of fragments

Figure 4.26. Design impression

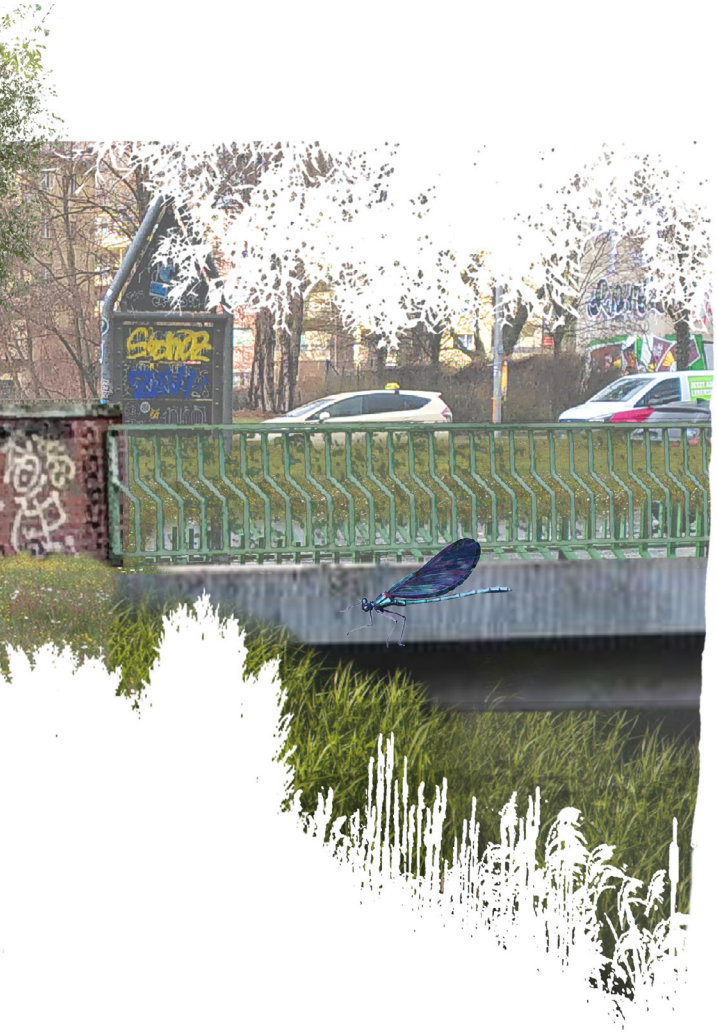


Figure 4.27a. Cyclists quickly travel along the Panke River during morning rush hour

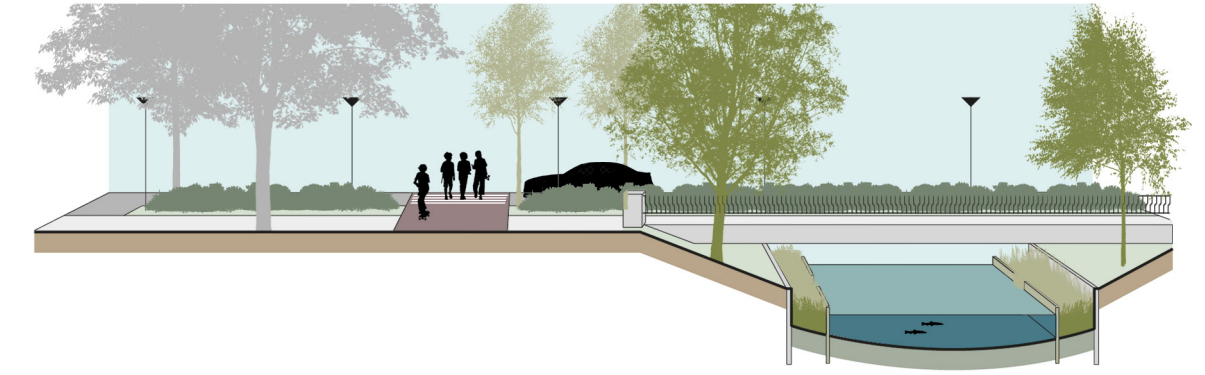


Figure 4.27b. Children can safely cross the street to reach their favorite playground

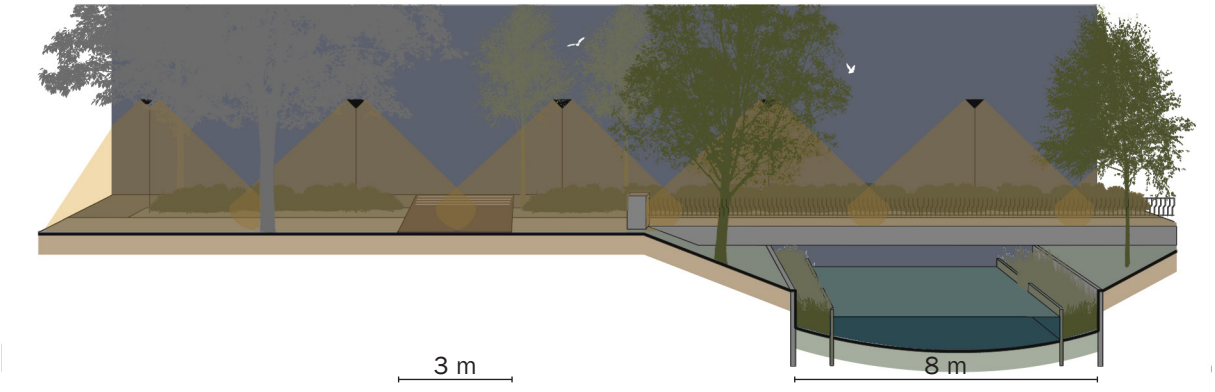


Figure 4.27c. Bats cross the street along a continuous tree canopy without being disturbed by strees lights

Figure 4.28. Location of visual and section

Use during the day
Connecting fragments of green space is important for humans and animals. Roads are an obstacle for all users. Pedestrians and cyclists benefit from safe priority crossings. Different species are better able to get across a bridge if vegetated riverbanks are continued under the bridge. Continuous tree canopy and customized lighting are significant improvements for bats.

Figure 4.29. Winter 2023

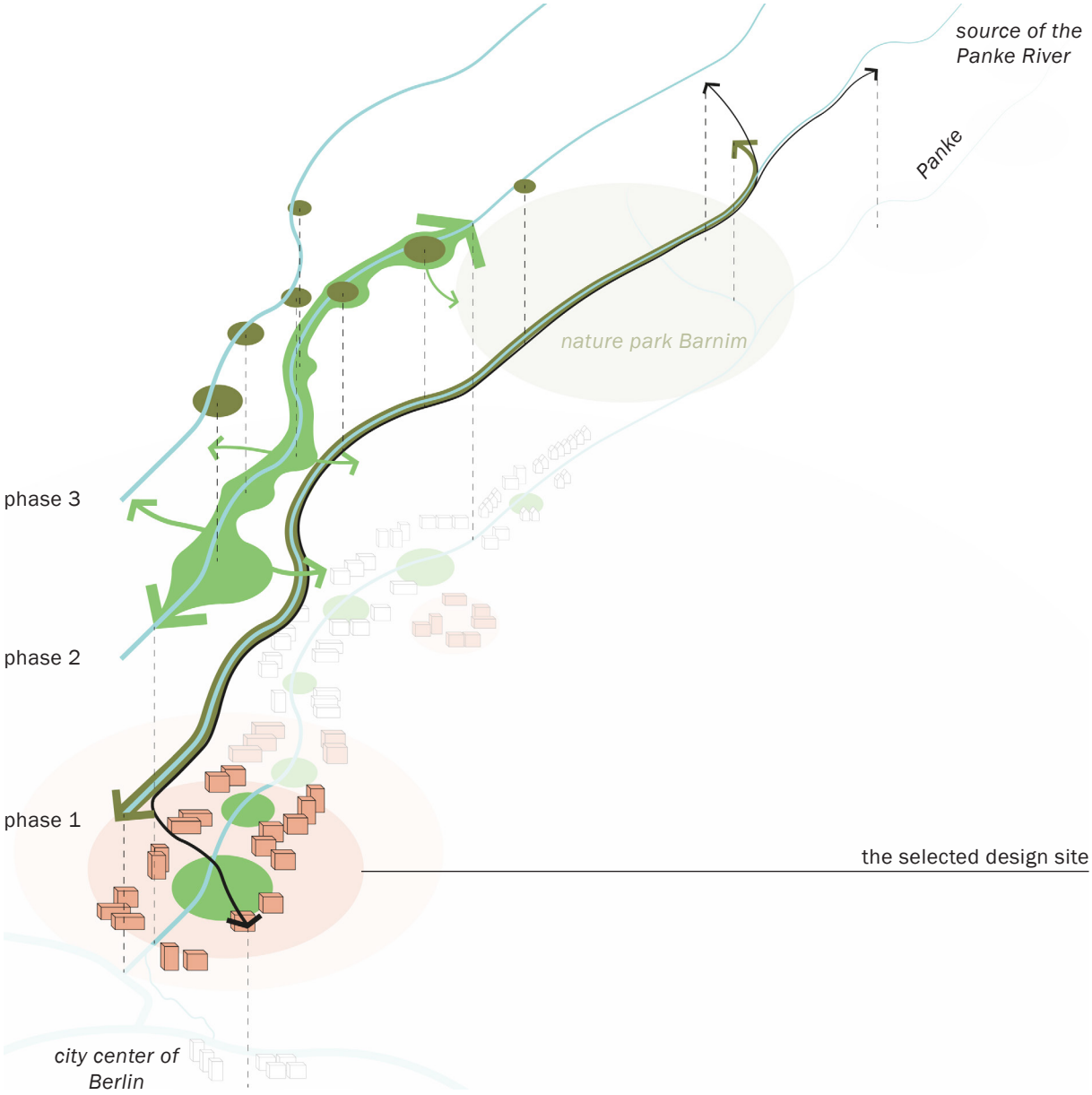


Figure 4.30. Phasing strategy for the Panke River

Phasing strategy for the Panke River

The design will be built in phases. Figure 4.30 shows the three phases of the construction. The elements of the design that are easy to construct and have a substantial impact should come first.

Phase 1: nature-friendly riverbanks and the main route
The first phase will focus on the nature-friendly riverbanks and the main walking and cycling route. This phase is relatively cheap and easy to construct and has a large impact. The continuous vegetation on riverbanks is crucial as a habitat for some species and to improve the connection of the nature-friendly patches in phases 2 and 3. The main walking and cycling route is the first step in connecting fragments of green space and improving the connection between the city and the countryside.

Phase 2: the first nature-friendly patches and connected green spaces
After most of the vegetated riverbanks are constructed, the first nature-friendly patches can be created along the river. The first patches should be constructed near nature park Barnim. From there, flora a fauna species can expand patch by patch towards the city.

One of the objectives of the design is to improve the quality of green spaces in neighborhoods with a substantial environmental justice problem. The main route is the first step. In phase 2, fragments are connected even better, and the quality of the green spaces is improved by redesigning fragments and the areas in between. Connections with the surrounding neighborhoods are added and improved.

Phase 3: more nature-friendly patches and more functions in the connected green spaces
Phase 3 will focus on the creation of nature-friendly patches near the city center of Berlin and adding the final elements to the connected green spaces. It is the final step in making the Panke River function as an ecological corridor and improving green spaces for people.

After phase 3: connecting more green spaces and adding nature-friendly patches
Realizing that both the budget of the city and available space are limited, the number of patches and connected green spaces are also limited. The most effective measurements are mentioned in the vision. Adding more nature-friendly patches and connecting more fragments of green space will lead to further improvements for the natural ecosystem and environmental justice. Later developments can elaborate on the vision of this graduation project.

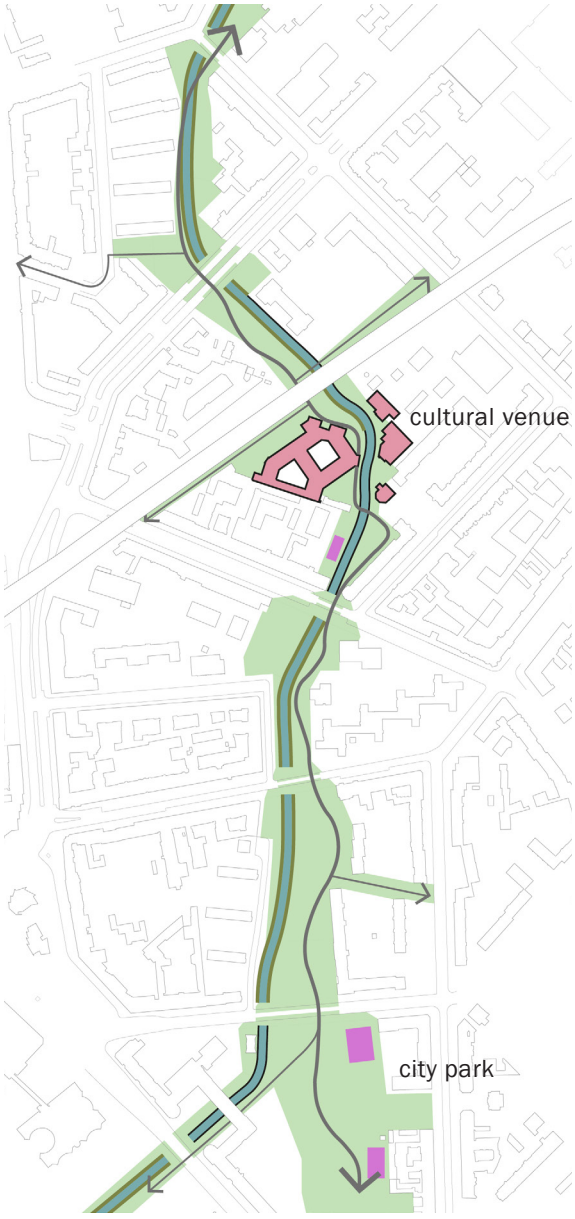


Figure 4.31a. Phase 1: Connecting green spaces

Figure 4.31b. Phase 2: Improved recreation value

0 50 250 m

Phasing strategy for the design site

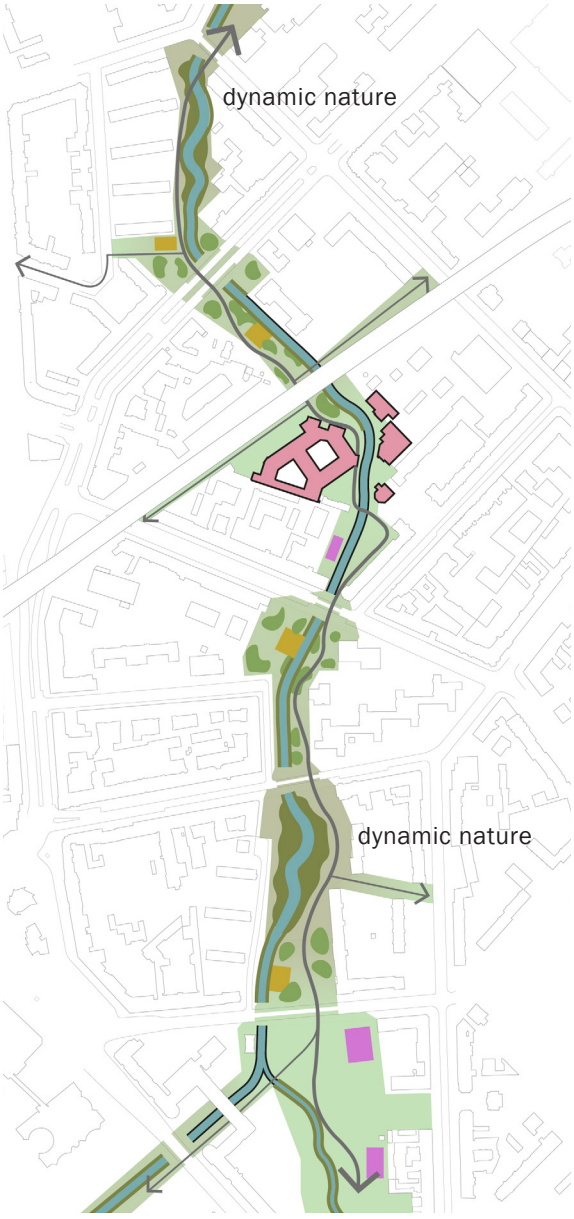


Figure 4.31c. Phase 3: Dynamic nature in the city

In the phasing strategy for the Panke River, the improvement of recreational quality is a priority for the designed segment. Riverbanks will be made nature-friendly in an early phase but natural patches follow at a later time. Figures 4.31a-c show the three phases of the implementation of the design.

Phase 1: Connecting green spaces

- Nature-friendly riverbanks
- Improvement of the walking and cycling route along the river
- New connections with the neighborhood

Preferably completed within one year from now

Phase 2: Improved recreation value

- Improved accessibility of the river banks
- Diversification of recreational activities

Preferably completed within three years from now.

Phase 3: Dynamic nature in the city

- Introduction of patches with natural dynamics
- The creation of vistas and the construction of watchtowers

Preferably completed within ten years from now.

The impact

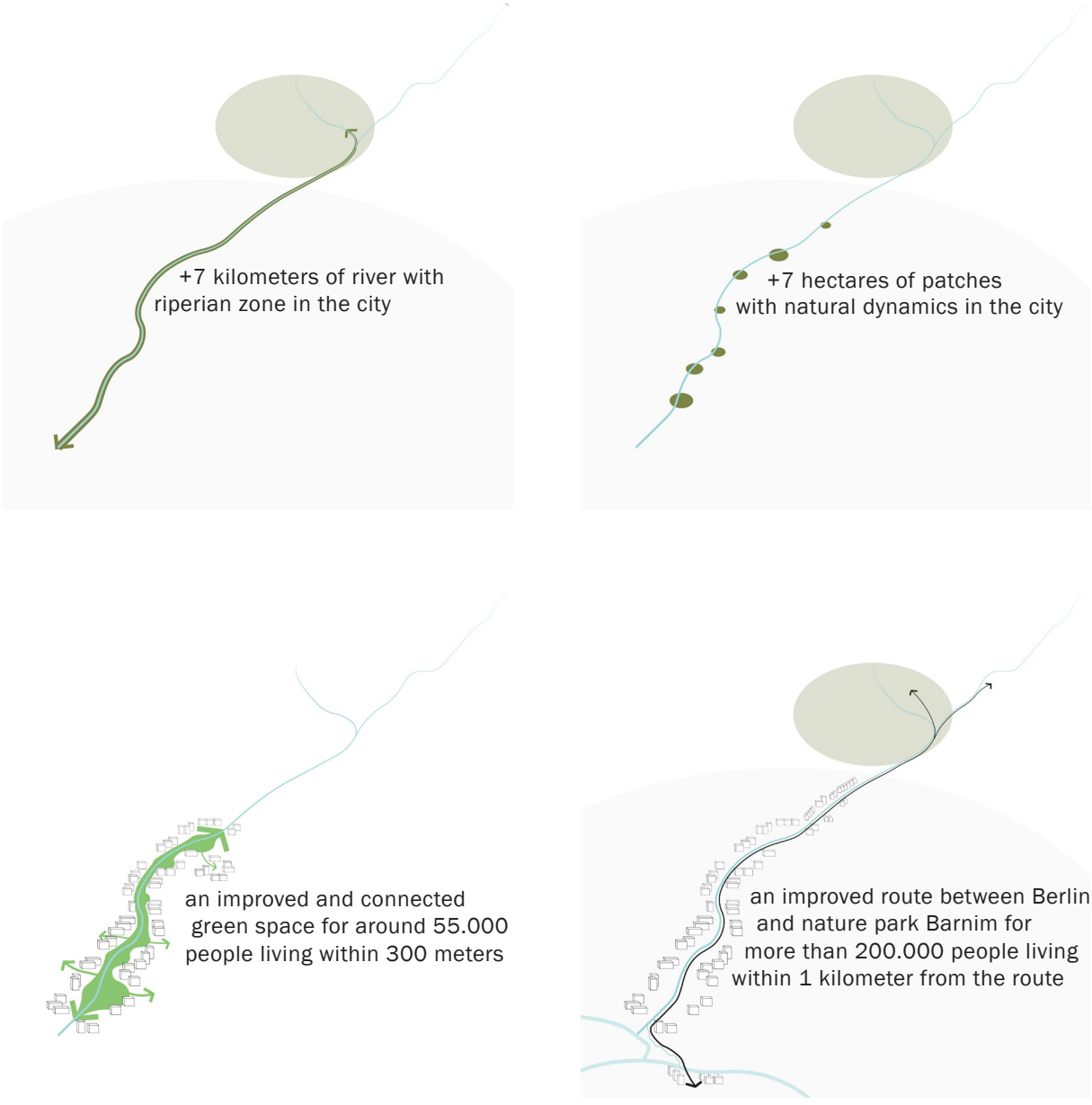


Figure 4.32. Impact of the design

Motivation for Berlin's government

Realizing two ambitions simultaneously

With the ambition to make Berlin more liveable for every citizen, now and in the future, the government of Berlin investigated environmental justice in the city. The gained insights will be used as an argument for measures in the fields of urban green, housing, living, and mobility (Senatsverwaltung für Umwelt, Mobilität, Verbraucher- und Klimaschutz, 2022). The results show that the research location of this graduation project is one of the areas with the biggest environmental justice problems.

At the same time, the waters of Berlin have to achieve a good ecological potential in the light of the European Water Framework Directive. The Panke River has been appointed as a pilot location, both the improvement is far from complete. As I have shown, environmental justice and the ecological potential of the Panke River can be improved simultaneously within one design project. By improving the quality of the green space along the Panke, the proposed ecological improvement of the river can be more valuable for the city.

Increased popular support for nature protection measures

Ecological improvement of Berlin's rivers is expensive. Especially people with a lower socio-economic status might not consider ecological improvements the most sensible way to spend money. Support might be a lot higher if ecological improvements are combined with improvements in the neighborhood. A successful upgrade of the green spaces along the Panke River can help to convince people elsewhere of measures for ecological improvements.

Design with locals

This project's design proposes an alternation of more natural and more recreational areas. Within this framework, the design is quite flexible. Input from local dwellers is needed to understand what types of recreation should be accommodated. These recreation types can get a place within the design as long as the ecological situation is not disturbed too much. The intensity and scale of the recreation types determined where in the design they will be accommodated.

Figure 4.32. Recreation by the Panke River at Panke Terrace (Zöllner, 2020)

5 Conclusion and reflection

Conclusion

Human modifications of rivers have a considerable negative impact on river ecosystems in Berlin, leading to a decline in ecological value and biodiversity. Rivers have been modified the most in dense neighborhoods near the city center. These are also the locations where environmental justice is a significant problem. People with a low socio-economic status generally have poor access to green spaces and their benefits and suffer more from environmental stress factors, such as noise pollution and heat stress. The Panke River was selected as the research location for this project as this river flows through areas with a substantial environmental justice problem and it is significantly modified. Along the river, the profile is narrow and green spaces are small and fragmented. The objective of this graduation project was to design optimized spatial conditions for the Panke River to improve the natural ecosystem and promote environmental justice.

A design vision was formed based on design principles that followed from scientific theory of landscape ecology principles and equitable green space access. Based on the vision and the analysis of the site, a smaller site was selected to apply this vision in a design. The needs of both humans and some target species were taken into account. The resulting design connects green spaces as one park in an area with a substantial environmental justice problem. A main walking and cycling route connects to the city center downstream and green spaces further upstream of the Panke River. Continuous vegetated riverbanks connect newly created nature-friendly patches with a nature park upstream, allowing the target species to expand into the city. An alternation between natural green spaces and areas that allow for different types of recreation minimizes disturbance of the target species.

Although the natural ecosystem of the Panke River can not be restored fully in the urban context, and the requirements of animals and human users often conflict, spatial conditions for ecology can be improved significantly. And although space is limited, an improved design and enhanced connections between existing green spaces can improve the accessibility and quality of green species significantly. Ecological landscape design for the Panke River can provide optimized spatial conditions for both the natural ecosystem and environmental justice by creating a diverse but well-connected landscape that takes the requirements of both target species and humans into account.

As a next step, the design can be improved with the involvement of ecologists and people living near the river. The design allows flexibility within the framework of alternations between more natural and more recreational parts. Other types of recreation can be allowed within this framework and the design of the natural patches can be improved based on ecological insights. The design vision can be applied in many cities around the world with similar ecological and environmental justice problems.

Reflection on the project

The challenge of defining a topic and research location individually

For me, one of the biggest struggles during this year has been to define the topic and location of my graduation project. The almost unlimited freedom that I had was often limiting my progress. Because my chosen topics are broad and complex and the city of Berlin is spatially highly diverse, I constantly changed my story, approach, and scale levels. A spectator of my mid-term presentation, just after the Christmas break, might hardly recognize the final outcome as being the same project.

Throughout the year, I've learned to constantly think about what my project is about. I constantly forced myself to write down the most basic version of the story to prevent myself from developing in the wrong direction and to ensure the quality of the story. New findings sometimes resulted in a complete overhaul of the story. In a professional career as a landscape architect, design assignments will never offer the same degree of freedom as was the case for this thesis. But I will use the experience of this year to become a better storyteller. I will also look at future, less open design assignments with a critical attitude. I am convinced that reformulating the assignment outcome often leads to better results.

The complexity of ecology and environmental justice

The ambition of my graduation project has been to improve both ecology (and related to this, biodiversity) and environmental justice in Berlin. I soon discovered that the problem of environmental justice in Berlin is the result of a large number of elements. Earlier in the process, my aim was to improve justice across the city. It took me a while to realize that it would be impossible for me, as a single landscape designer, to improve environmental justice across the whole city. I also learned that solving environmental justice completely is a myth. I had to focus on either one the improvement of one element of environmental justice or on one location.

Regarding ecology, I did also discover a large complexity. Both the landscape and the ecological challenges are complex and diverse. Again, too much for a single landscape designer to solve. To be able to improve the ecological situation, it was needed to zoom in. This led to my decision to focus on the Panke River: one landscape element in the city. A single ecosystem type and an area with more or less fixed boundaries.

As a result of this choice, my design does not solve the problems of ecology, biodiversity, and environmental justice in the city completely. But, although it is a small step, the design has the potential to improve the situation significantly in a part of Berlin.

The difficulty of bringing nature into the city

My ambition for the project was to bring nature back into the city, to blur the boundary

between the city and the natural surroundings. This has turned out to be harder than I expected. Even if the Panke River would be renaturalized to a large extent, fewer species would regard it as a suitable habitat than I expected. Many species have requirements for patch size, proximity to patches, and corridor quality that can not be met in the dense neighborhoods along the Panke River. Just as problematic can be the sensitivity of many species to human disturbances. Therefore, the characteristics of an urban river will always be different from its natural counterpart. I had to accept that urban nature is unlike its natural counterpart.

How research and design influenced each other

In the first place, my design is the result of my research. Research on the topics of ecology and environmental justice has been my basis to choose a location for the design. The theoretical framework, which is about design principles of ecological corridors and the 3-30-300 rule, has informed me about how I can make a design that answers my research question.

In the second place, the research I have done is also influenced by the design. Drawing the vision, applying the design principles, and making detailed designs constantly led to new questions. It did also become increasingly clear what I could learn from the theory that I found. Only after more research, I was able to make further steps in the design.

The approach

Urbanization has led to the degradation of river ecosystems in Berlin. The remaining green spaces along rivers are often narrow, fragmented, and managed or constructed in a way that limits the ecological potential. Many species related to natural river ecosystems are absent in the city. A second problem in the city is the issue of environmental justice. Generally, people of low social-economic status are more affected by environmental burdens and have poorer access to green spaces. Both problems are most prominent in the dense neighborhoods near the city center. The Panke River was chosen as the research location, as it is the best case of a degraded river flowing through areas with a sizable environmental justice problem in Berlin. Consequently, the research question is: “How can ecological landscape design provide optimized conditions for both the natural ecosystem and environmental justice of the River Panke in Berlin?”

Analysis revealed that the Panke River is highly modified. Urbanization has left little open spaces along the river. Many fauna species related to the natural landscape of a lowland river have demands that are too high to meet. It is therefore unrealistic to expect a fully restored natural ecosystem. However, renaturalization could still attract a large number of less demanding species. The uncertainty about the effectiveness of renaturalization to

attract fauna is high. In this project, only an educated assumption has been made about the possible result. Further research, preferably done by ecologists, is needed to test the assumptions.

The next step was to select a body of scientific theory to form the basis of this graduation project. Two scientific publications have been chosen: one publication about landscape ecology, and the other about guidelines for more equitable access to urban green spaces. The publications have been chosen as they both have landscape designers among the target audience. Working with only two publications is a limitation, as they include only one perspective on the available knowledge of both fields. On the other hand, both publications provide designers with the required basic level of knowledge that is needed to design. The chosen publications are clear and easily applicable in the design phase.

To be able to make a theory-based design, design principles have been formulated. In this project, the formulated design principles are a translation of the scientific literature. This makes the design principles better applicable in the specific context of the design. Although carefully selected, only a small proportion of the theoretical publications is reflected in the design. Including more of the theoretical framework in the design principles would have led to a more powerful design. However, within the limited time of this graduation project, making a selection was needed.

The step after formulating design principles was to make a vision. The aim of this step is to incorporate the different design principles in a spatial organization. The vision shows how and where the landscape will change. It became clear that it was not possible to improve the ecological situation and environmental justice separate from each other. Therefore, the vision shows how a smart combination of design principles can lead to an improvement of both. The extra step of formulating more specific design principles might have been a valuable additional step. This would have led to a more systematic approach to the design. On the other hand, the chosen less systematic approach resulted in more freedom for creative solutions in the later design steps.

The design for a small proportion of the Panke River shows how the landscape can be improved by applying the found design principles. By connecting greenspaces and establishing a variety of recreational and ecological core areas, a fragmented landscape can be transformed into a park with high recreational and ecological value. The design is principally based on scientific literature. The involvement of ecologists, local dwellers, and other professionals and stakeholders would enhance the effectiveness of the design. Another next step could be designing other fragments of the Panke within the same vision. This would help to better place the small designed part in the larger context.

Improvement of the ecological value of the Panke River

Improvement of the river bank of the Panke is always related to the larger context. The ecological potential in Gesundbrunnen, the designed downstream part of the river, is influenced by water quality, connectivity, and habitat quality upstream Water quality of the different sources does not fall within the scope of this research project but should be part of an actual implementation. The connection to the downstream Spree River is also underexposed in this project. A higher ecological quality of this river would increase both the need and the effectiveness of improvements to the Panke River.

Improvement of environmental justice along the river Panke

Environmental justice is a concept of equal distribution of environmental burdens and equal access to green spaces in the city. The introduction has shown that the issue of environmental justice in Berlin has multiple reasons. A design for a river corridor can only improve environmental justice to a small extent. With the design of the banks of the Panke, it is possible to improve the accessibility of green spaces. However, improving the aspects of 'viewing green' and 'living among green' involve improvements in streets and neighborhoods as well. This is beyond the scope of this project.

Environmental justice is about procedural and recognition justice as well. These are types of environmental justice I, as a landscape architect, have less influence on and experience with. Citizen participation would certainly have enriched my project and would be a logical next step. As the design does not have to be built in one go, users of the park can continue to have an influence on the design in a later phase. After a part of the design has been built, the design can be adapted to their needs.

Societal value

The combination of climate change, urban sprawl, and densification is a threat to cities around the world. The availability of and accessibility to urban green spaces will become more important. But often, cities are densely built and more green space is difficult to add. With this graduation project, I want to show how existing green spaces can be improved. By doing this, livability in the city can be improved in a cheap but effective way.
Many people value being in nature. In the city, nature is often far away. Rivers are an excellent starting point to bring nature into the city, close to where people live. The daily experience of nature will be achievable for a large number of people in Berlin.

Ethical considerations

This graduation project takes an ethical consideration as a starting point. The aim of this thesis is to increase environmental justice. Environmental justice in the city has

been the basis for the analysis of the city and the vision for the design. With my design, environmental justice can be improved by a small but significant step in the city of Berlin. The quality of the environment of a large group of people with a low social status would improve. However, improvements in the living environment have a well-known downside. That is the process of gentrification. Improved living environments can lead to higher housing prices. The people that the design was made for might not be able to live in the area anymore. To prevent this from happening, it might be important to improve the quality of the environment only to a limited extent. Design what people need, but don't overdo it. Another solution might be not to focus on the Panke River only, but to improve many more neighborhoods and green spaces all around the city simultaneously.

A second consideration is the question of who has the right to use the landscape. How much space should be devoted to nature and how much to human recreation? In a dense city, green space is limited. From an ecological perspective, it would be highly effective to exclude people from the river banks of the Panke River. For the common kingfisher, for example, a radius of 50 meters without human interference is recommended around breeding walls. Similarly, there would be more space for human recreation if space for nature is limited. In the limited green space around the river Panke, a radius of 50 meters takes up a lot of space. The construction of an ecological corridor in the city should not result in a landscape that is poorly accessible to humans. Landscape designers can be the ones creating spatial solutions to accommodate both nature and recreation. With my design, I hope to have found the best balance between both goals within the local context. More research is needed to understand the specific needs of the target species. If the chosen target species have too demanding needs, other target species could be considered.

Transferability of the project results

The design that I have made is very site-specific in the end. However, I think that the same approach – or even the same vision – can be applied in other parts of Berlin, in other cities in Germany, and in other cities in northwestern Europe. In other parts of the world or Europe, this approach might not be the best approach. Ecosystems are different, as well as the historical development of cities. On the other hand, worldwide many people live in dense cities, close to a river. Many people would benefit from riverbanks being proper recreational areas. Problems of degraded river ecosystems exist worldwide.
In the parts of the world with the highest ecological potential, the number of people is often sharply increasing. Cities are expected to grow by a lot in for example Africa and India. I hope that ecology-inclusive design can be adopted in these expanding cities before ecosystems are destroyed as much as in the cities that have been developed during the last centuries.

The relation of the graduation project with the graduation lab, the graduation studio, the master track, and the master

Within the Urban Ecology and Ecocities lab, the landscape is approached through the lens of urban ecology and another chosen lens. In this project, the lens of urban ecology - or more specifically, the lens of urban river ecosystems - is combined with the lens of environmental justice. With these two lenses, I have aimed to achieve the goal of the lab: improving the quality of life and environmental performance in cities through landscape architecture. The quality of life by looking at the river Panke through the lens of environmental justice and environmental performance by looking at the river Panke as an ecological corridor in the city.

The Urban Ecology and Ecosyties lab is a graduation studio within the Flowscapes graduation studio. The studio discusses 'infrastructure as landscape' and 'landscape as infrastructure'. The smallest interventions have a relation with large-scale problems. Floating plants in my design project, for example, improve water quality and provide insects as food on a very small scale. This intervention is only one of the interventions to improve the ecological value of the river Panke, thereby increasing biodiversity in Berlin, relating to a worldwide biodiversity crisis. One improved road crossing can improve the accessibility of natural areas for a large number of people in Berlin, providing ecosystem services in a city that gets warmer as a result of climate change.

The Landscape Architecture master track deals with making space inspired by nature, art, and technology. The formal, material, and cultural qualities of the site are the starting point for design. In my case, I try to find a balance between the current cultural and man-made Panke and the natural conditions of the river. Inspired by nature, I have found solutions to create natural environments within the man-made landscape of Berlin. Finding these and other innovative solutions is the main goal of the Architecture, Urbanism, and Buildings Sciences master track.

Working through scale, time, and process is another key element of the master track. My design related small interventions with city-wide or worldwide problems with a site-specific approach. In my design, I use time as a design tool, when creating natural breeding walls for kingfishers. I am aware of cyclical processes when designing floating plants on a river with changing discharge volumes. I could have made a better design with a better understanding of the larger scale. Both the analysis of the larger scale and the effects on the larger scale could have been worked out in more detail.

Reflection on landscape architecture

Landscape: a geographical, ecological, and social construct and process

The word landscape can have multiple meanings. It can be defined as a painting, as a geographically homogeneous area, as an area designed and shaped by humans, as an area untouched by humans, and much more. This variety of (contradictory) definitions shows: landscape is a complex concept. However, it is always used as a concept to define and understand the world that we live in, based on our human perception. Landscape is more than just physical space. It is also theintangible. "Landscape is both nature and culture, it is the expression of who we are (...)" (Jacobs, 1991). Landscapes can offer meaning to the ones living in them and caring for them. "Landscape, as cultural as much as an ecological and geographical construct, is the habitat for humankind, the place where people live out their lives (Moore, 2015)."

As Dixon Hunt (2015) writes, every site has a history. The landscape is a palimpsest, a temporary result of an ongoing process. The interaction of natural processes, human processes, and cultural meaning determines our ever-changing perception of landscapes.

Social and ecological challenges and landscape architecture

The world becomes increasingly occupied by humans. This comes with large challenges for us, mankind. Ecological processes around the world are under large pressure. Many ecosystems have been changed by humans in a dramatic way. Biodiversity has dropped and the homogenization of landscapes has led to placelessness (Relph, 1976). Society increasingly suffers from climate change. Living quality is under large pressure. Landscape architecture can help to mitigate the effects of climate change and placelessness on humans and help to restore ecosystems. The big challenge for landscape architects is to find innovative solutions for the multitude of different problems in landscapes.

The role of landscape architecture

Landscape architects should always be aware of the temporality of landscapes. Natural and cultural processes continue to shape the landscape. Design can only influence the future of a landscape, not define it. But how should we influence this process?

As landscape design is a complex practice, landscape architects have written a large and varied body of literature about procedural theory. At the start of the second half of the 20th century, landscape theory was more result-oriented. Sasaki (1950), for example, proposed a linear process with three steps: research, analysis, and synthesis. Although these steps are still very relevant, I think that simple, linear approaches are not adequate anymore for understanding and solving the complex challenges that we as landscape architects want to solve nowadays. I agree with Halprin (1969) that landscape architecture should be more than just science. A creative, open, process-oriented design approach is needed. Being able to work with knowledge of the natural sciences in a creative, almost artistic way is a fundamental quality of landscape architects (Gazvoda, 2002).

An essential quality of landscape architects is being able to connect different scale levels and switch between them. This makes us able to "achieve different and often better results than might be developed by architects, artists, urban planners, biologists, ecologists and other colleagues when dealing with similar landscape problems" (Gazvoda, 2002).

The social aspect of landscape architecture

As a landscape architect, one can contribute to the quality of life. The quality of life is determined by physical, ecological, and geographical aspects, but also by the meaningfulness of the landscape and the sense of belonging (Jacobs, 1991). Marc Treib (1998) explains how creating a singular meaning is difficult, if not impossible. Meaningful landscapes can only arise "through the involvement and commitment of the people who live and work in them" (Relph, 1993). Nonetheless, designers can create opportunities for use, that will result in the development of meaning.
I agree with Randolph Hester, jr. (1974) that designers have to take more responsibility to create more "socially suitable neighborhood spaces". Although this is difficult in practice, landscape architects always need to question the assignments that they are given. Space is limited and often scarce. Only a small number of people have the power and expertise to change the landscape that humans use and care for. Landscape architects should always have the ambition to create the best living environment and meaningful places for the largest number of people, even if it is not in the design brief.

The ecological aspect of landscape architecture

Ecological landscape design can be the link between the built human landscape and the natural landscape (Steiner, 2015). According to McHarg (1967), landscape architecture is even "the only bridge between the natural sciences and the planning and design professions." I am not sure if this is true, but as landscape architects, we surely are better in making this bridge than other design disciplines (Gazvoda, 2002). We are able to combine the knowledge of multiple disciplines on different scale levels and relate this with human perception. Designing at the human scale is crucial for successful ecological landscape design. We can only create a world with more sustainable landscapes if people accept these landscapes and start to care for them (Thayer, 1994).

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