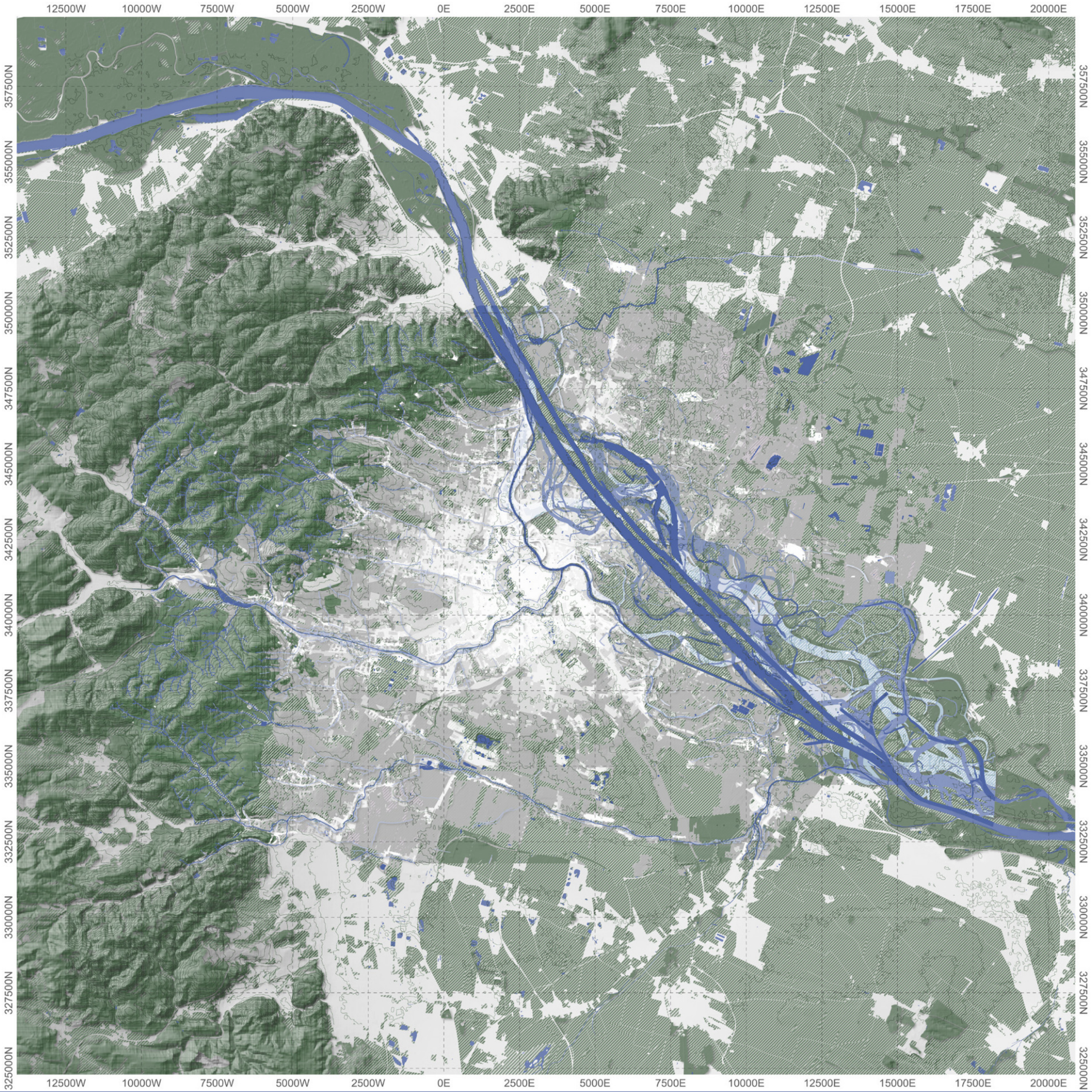
GRADUATION STUDIO REPORT

METROPOLITAN ECOLOGY OF PLACES SERIES

# Vienna
# Water City

## Transitioning towards climate resiliency

Leon Morscher



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*"We must become the stewards of the biosphere. To do this, we must design with nature."*

-

Ian McHarg (1969, p.5)

[Fig. 1]: Urban  and lanscape development overlayed, showcasing the gradual displacement of nature

*Datasource: Hohensinner et al. 2012-2023, Stadt Wien 2023*

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All the drawings in this thesis are drawn by the author
All the photographs in this thesis are taken by the author unless stated otherwise


[Fig. 2]: Plants growing along construction fence in Vienna


[Fig. 3]: Historical map of Vienna 1530
*Source Meldemann 1530*

# Vienna Water City

## Transitioning Towards Climate Resiliency

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METROPOLITAN ECOLOGIES OF PLACES STUDIO


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# Abstract

This thesis project explores the imperative of strenghening Vienna's climate resilience through mitigating weather extremes and fostering knowledge of them by reimagining its current water and ecosystem dynamics. The central focus is on integrating a blue-green infrastructure into the urban environment and a just distribution of their services, thereby establishing a balanced coexistence with the ecosystem.

The objectives encompass mitigating pressing urban challenges such as the urban heat island effect and biodiversity loss, while fostering awareness of the symbiotic relationship between a healthy ecosystem and human well-being. These efforts are pivotal in the city's journey toward climate resilience and adapting to dynamic climate conditions.

The broader aspiration is to illuminate a path towards socially and environmentally sustainable urban transformations.


[Fig. 4]: Vienna river at Schönbrunn

# Table of Contents

# 1. Introduction: Clima
# Marginalized Ecosyste

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This chapter introduces the discourse of the graduation project. It provides personal motivation and contextual information on the problem as well as positioning in the theoretical discourse of planning for climatic resilience regarding water. Finally, it presents the social and scientific dimensions of relevance.

# 1.1 Motivation: The resilience of nature as a paragon

This research project has its roots in years of observation, fascination and academic engagement with urban environments, as well as a deep appreciation of nature and ecological processes.

## Personal motivation and education

My early fascination with cities as hubs of cultural, knowledge, and social exchange ignited a profound interest in understanding their composition, urban morphology, and social dynamics. I viewed cities as spaces for freedom, the pursuit of curiosity, and the fulfillment of personal needs—a catalyst for civilization.

This passion guided my decision to pursue a career in studying the built environment, with a foundational principle of embracing diversity and multiplicity. However, I soon realized that prevalent city planning and education were predominantly rooted in the Anthropocene paradigm, prioritizing movement and efficiency over landscape and ecology, often as an afterthought.

In contrast, my deep appreciation for nature, nurtured by my family background, has been a constant in my life. Nature's beauty and tranquility have been a source of strength and balance, influencing my overall well-being. Yet, the concerning treatment of nature has become a significant focus in my explorations.

*Throughout my engagement with urban environments, I've marveled at nature's resilience—its ability to adapt and respond to new situations with flexibility, finding new paths despite disturbances .*

Therefore, integrating ecosystems into the built environment has been an early endeavor, though primarily from the perspective of human well-being and city functionality.

Studying at TU Delft has deepened my understanding of cities and landscapes as intricately interwoven systems. It has equipped me with the tools to analyze territories based on their morphological processes and their cultural shaping. This education has instilled in me the importance of viewing ecological systems as a fundamental principle in shaping the built environment, fostering a co-creative transformation that plans for adaptation rather than merely robustness, or engineered resilience. I am enthusiastic about further developing this knowledge and seamlessly integrating it into my design process.

## Focal point: Viennas water system

Water, with its intricate hydrological system, serves as the central nexus—the meeting point between landscape and urban morphology, the foundation for life, and a critical element in the transformation of the socio-ecological system. It operates as a driving force, essential for ensuring the well-being of the ecosystem and humanity.

The decision to focus my thesis on Vienna stems from the belief that this city uniquely embodies a convergence point for diversity, culture, and familial connections to the landscape. Vienna presents a captivating blend of potentials and challenges crucial for the transformation of its water system.

The escalating climatic extremes and growing social segregation act as alarm signals, urging us to reconsider our way of life, which has long been relying on the exploitation of nature and vulnerable segments of our society. Motivated by the resilience inherent in our ecological system, my goal is to explore alternative ways of urban living that align with the imperative need for a sustainable transition.

[Fig. 5]: Roots taking a new path shaped by urban environment


[Fig. 6]: Newspaper articles: Vienna most livable city



# 1.2 Problem field: Vienna livable city - climate resilient city?

Vienna is one of the most performing cities in the world, since it was repeatedly voted as the most livable city within the last years. However, in order to tackle climate challenges our cities have to move forward. Is Vienna prepared for increasing intensity, duration and apperance of climate extremes? Or is it ready for a change?

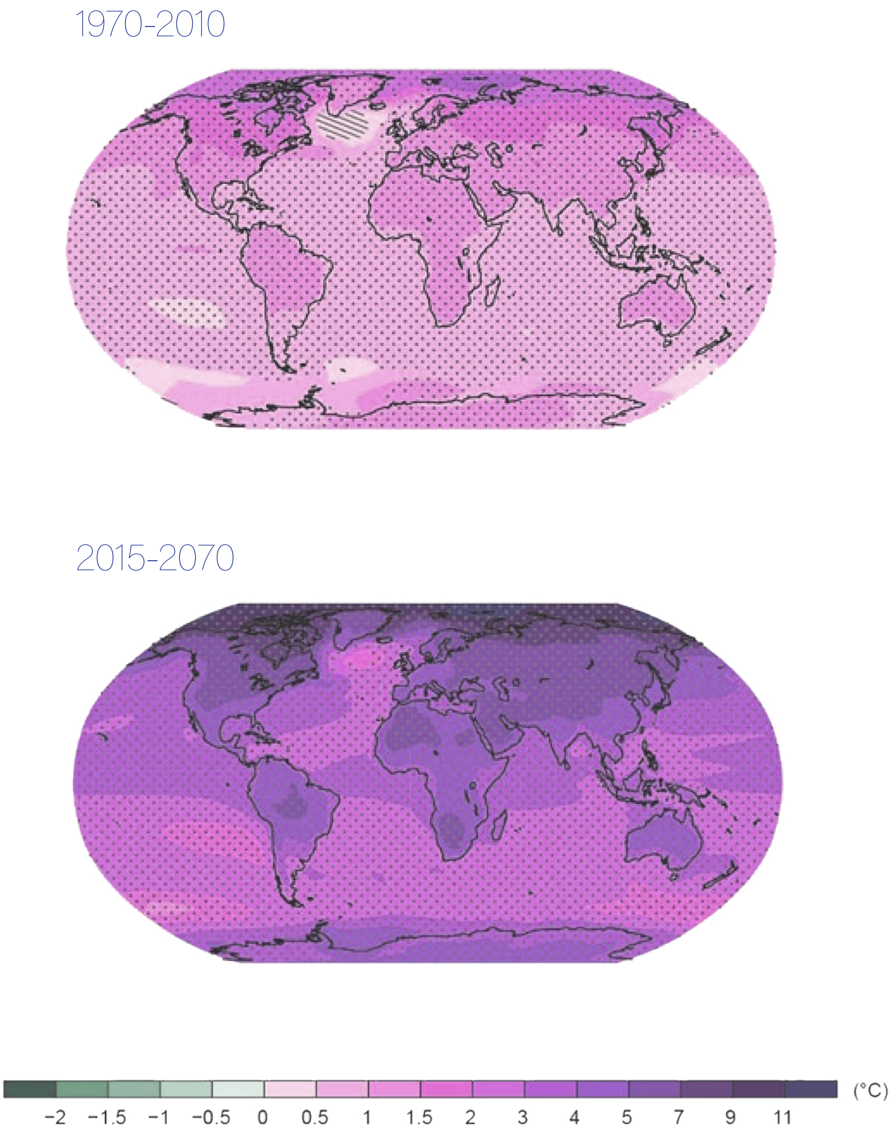
## Climate change and its spatial & Social consequences

The world is heating up, according to estimations of the IPCC the global surface temperature increased in some regions already by 1 C and an global increase of 1,5 C is already not to prevent.

Spatial consequences follow not only for regions that are in danger of rising sea level or lack of water, but also for mountainous regions that especially heat up, Austria is one of them. With increased heatwaves comes increased need and use of water. Based on spatial conseuqences social consequences, especially for the most vulnerable of our society will follow. People that can't afford cooling or increased water demand, people that can't afford to escape to areas where edurable living conditions are provided.

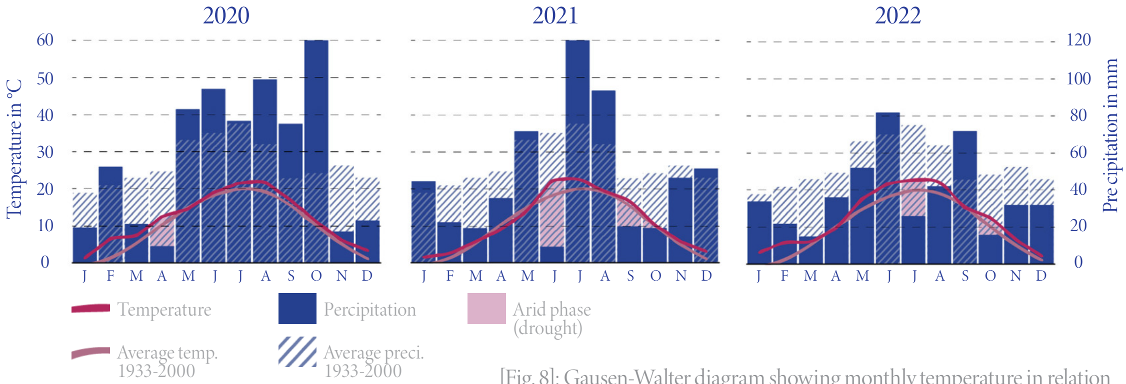
*Climate change results in spatial and social consequences and a shift in the way we live. Making it a necessity to have climate-resilient cities to have livable cities. But is Vienna climate resilient and for whom?*

Climate resilience means in this context the capacity to withstand climate extremes and provision of systems that mitigate this extemes to ensure well-being of its inhabitants. It means the capability to reorganize and still retain same functions and identity.




[Fig. 7]: Global average surface temperature change
*Source: IPCC, 2014*

## 1.2.1 Climate challenges in the spatial context of Austria




[Fig. 8]: Gausen-Walter diagram showing monthly temperature in relation with percipitation , each year compared with average values (1933-2000)

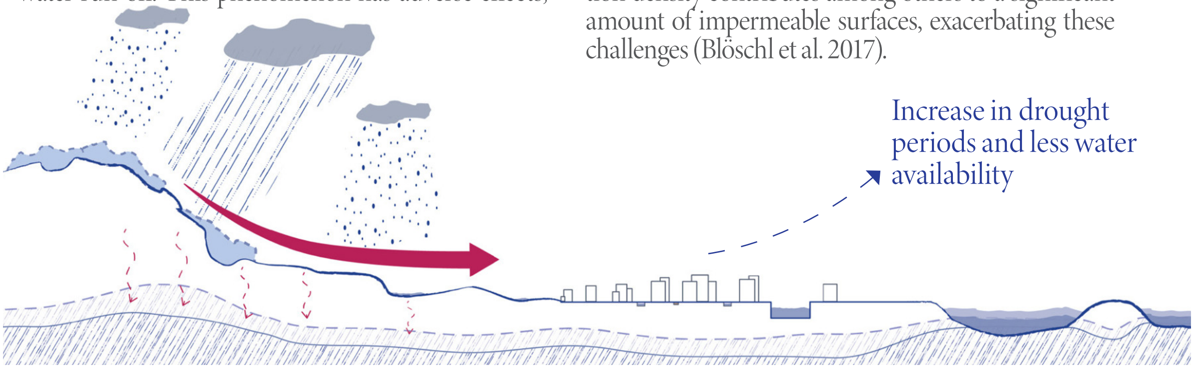
*Datasource: Stadt Wien 2022:*



Although Vienna typically experiences lower precipitation compared to other parts of Austria, it seldom faces water shortages due to its proximity to the rain-capturing Alpine region of Europe. However, the Alps are undergoing significant changes, warming at nearly twice the average rate due to reduced snowfall, shorter snow cover durations, and glacier melt. These mountains act as reservoirs, storing water and releasing it during warmer periods (Olefs et al. 2021; Viviroli et al. 2004).

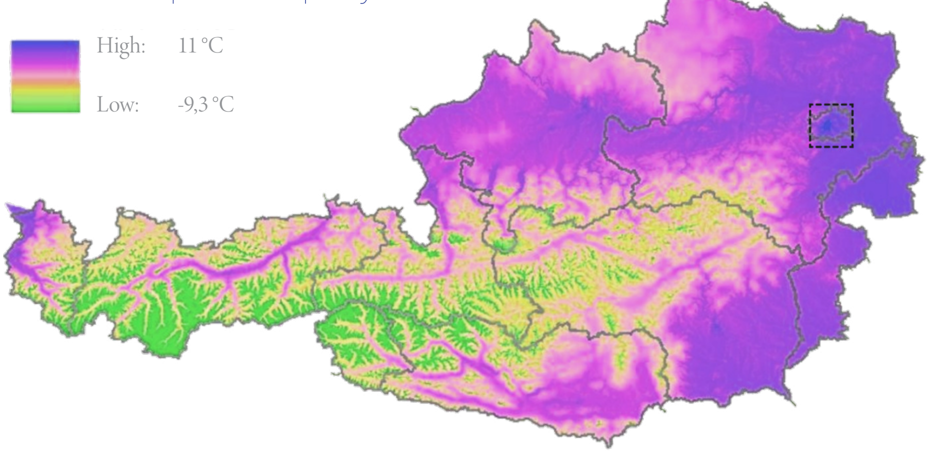
As a consequence of reduced water retention during wet periods, the city is witnessing more intense water run-off. This phenomenon has adverse effects, including decreased groundwater infiltration, lower groundwater levels, and erratic water run-off, particularly during dry spells (Blöschl et al. 2017; Viviroli et al. 2004). Unfortunately, these dry periods are becoming more frequent, climate change is leading to more frequent extreme weather events, as indicated in Figure 8.

The rising temperatures and prolonged dry spells are having a distinct impact on our cities, particularly Vienna. This vulnerability arises from Vienna's unique geographical location at the intersection of different climatic zones, embedded between the Alps and the Pannonian Basin. In addition, the city's high population density contributes among others to a significant amount of impermeable surfaces, exacerbating these challenges (Blöschl et al. 2017).




[Fig. 9]: Increase in water shortage and run-off extremes

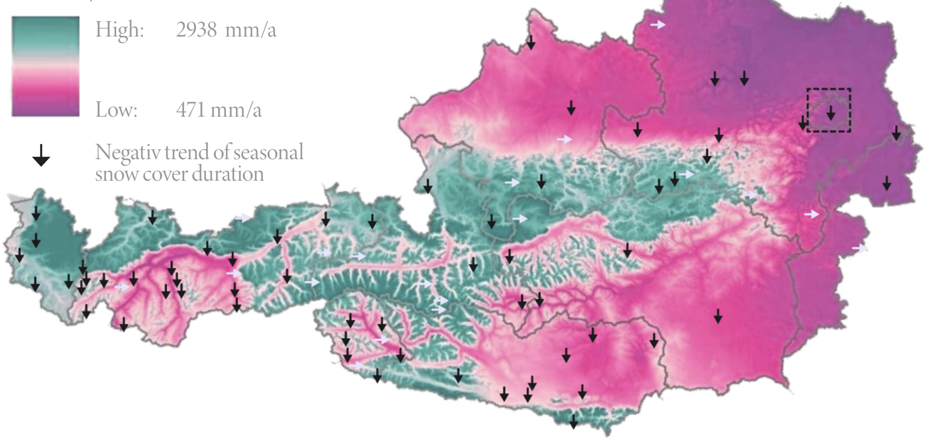
# Mean temperature per year




[Fig. 10]: Mean temperature per year with climatic zones
*Source: Olefs et al., 2021*

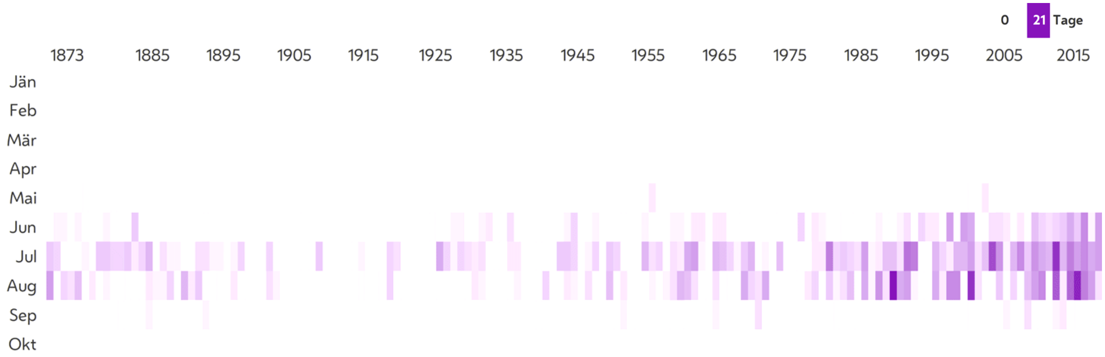


# Precipitation




[Fig. 11]: Mean pre cipitation per year with seasonal snow cover duration trends (1961-2019)
*Source: Olefs et al., 2021*

## 1.2.2 Changing climate patterns and its effect on the system of Vienna




[Fig. 12]: Development of heat days above 30°C (Stadt Wien 2022)

Climate change, characterized by erratic weather patterns, coupled with urban development that has historically marginalized the natural ecosystem, causes urban heat islands and heat stress for the population. For many years most cities were built in a way that prioritizes efficiency and movement as well as marginalizes the risk of natural hazards, like flooding or pandemics.

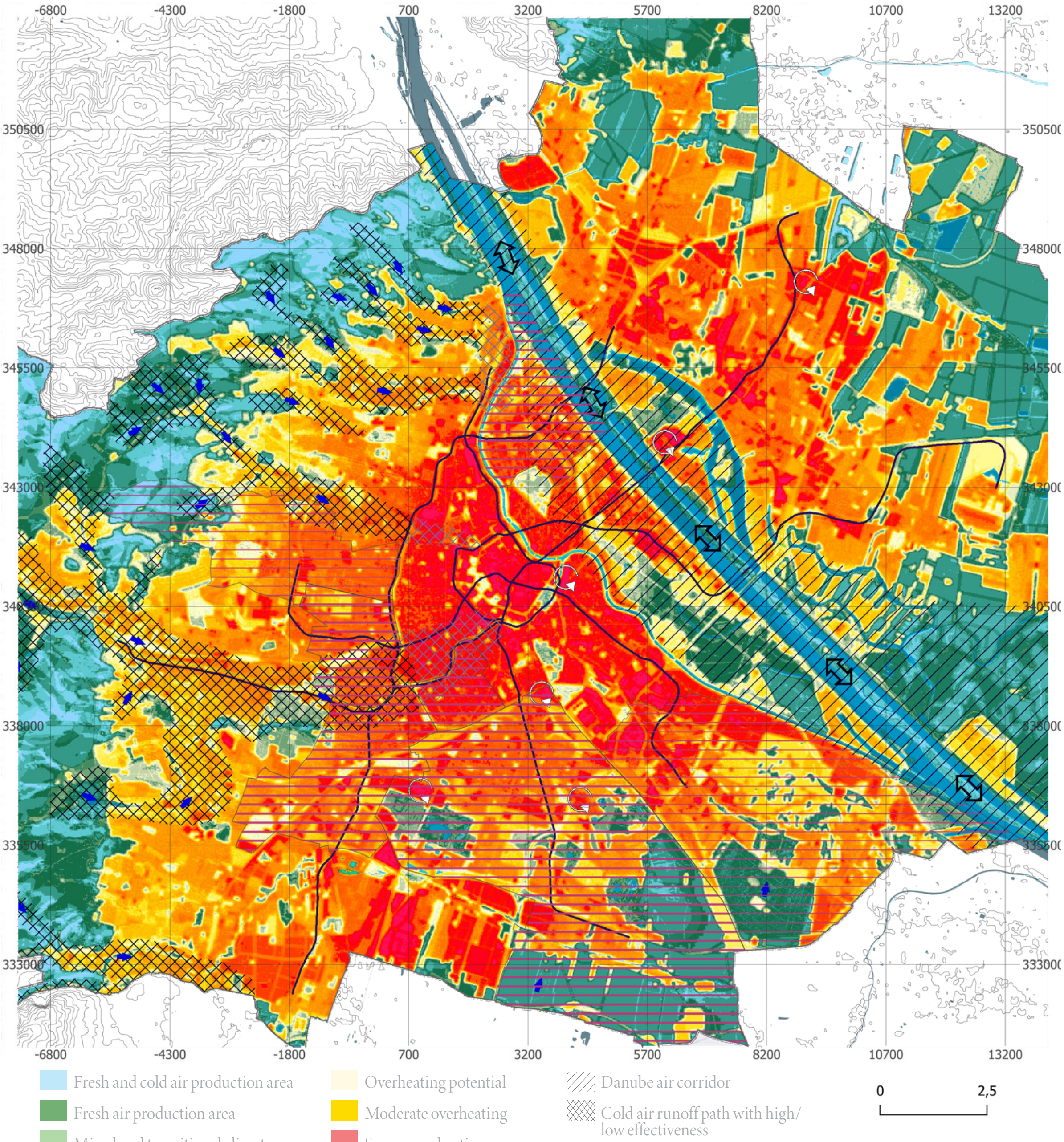
Motorized private transport completely changed the way we approach public space. It resulted in a final displacement of ecological systems through the sealing of most surfaces. Supported by a financial system that provides spatial and environmental qualities and amenities primarily for wealthy people within a city, Vienna, like many cities, is highly vulnerable to changing weather patterns resulting in overheating (see Figure 14). As shown in Figure (12), there has been a sharp increase in heat days above 30 degrees over the past 15 years. Predicted climatic changes will continue to increase the number of heat days and overheating in Vienna.

### Vulnerability to overheating

Especially vulnerable to the overheating of Vienna are, on the one hand, physically vulnerable people, so elderly and children, but also sick and disabled people. Their residence within Vienna was the baseline for the climate vulnerability map of Vienna shown on the right. On the other hand, socio-economic disadvantaged people are highly vulnerable to the changing weather and climatic conditions. They have limited access to climate mitigating means and few possibilities for a transformation of the living space.

*Vienna is not climate resilient due to its vulnerability to overheating, resulting in a decrease in livability. But why is it overheating?*


[Fig. 13]: Election poster "Die Grünen" in Vienna: "When does the heat start to bother you?"




[Fig. 14]: Urban heat island vulnerability in Vienna
*Retrieved: Stadt Wien 2020*

## Impact of density on fragmentation and distribution of green-blue spaces


[Fig. 15]: High sealing and little infiltration

Vienna's overheating is measured through the land surface temperature (LST). Through satellite driven LST analysis, conclusions can be drawn on its urban heat islands (UHI) and land surface.

The Urban Heat Island (UHI) effect is a phenomenon where urban areas like Vienna experience significantly higher temperatures than their surrounding rural areas. This occurs primarily due to human activities and the built environment in cities. The UHI effect is characterized by increased heat absorption and retention in urban materials like concrete and asphalt, reduced and fragmented-vegetation, energy use, and heat generated by various sources, including vehicles and industrial processes.

This leads to elevated temperatures, especially during hot summer days and nights, and can result in several adverse effects. This includs health risks, as extreme heat can lead to heat-related illnesses and exacerbate existing health conditions, environmental impacts for local ecosystems and increased energy consumption. In conclusion it results in reduced quality of life, particularly for vulnerable populations (Oke 1982).

***High population density and high land surface temperatures are directly related in Vienna. This is caused by a marginalized and uneven distributed green-blue system. How did this evolve?***

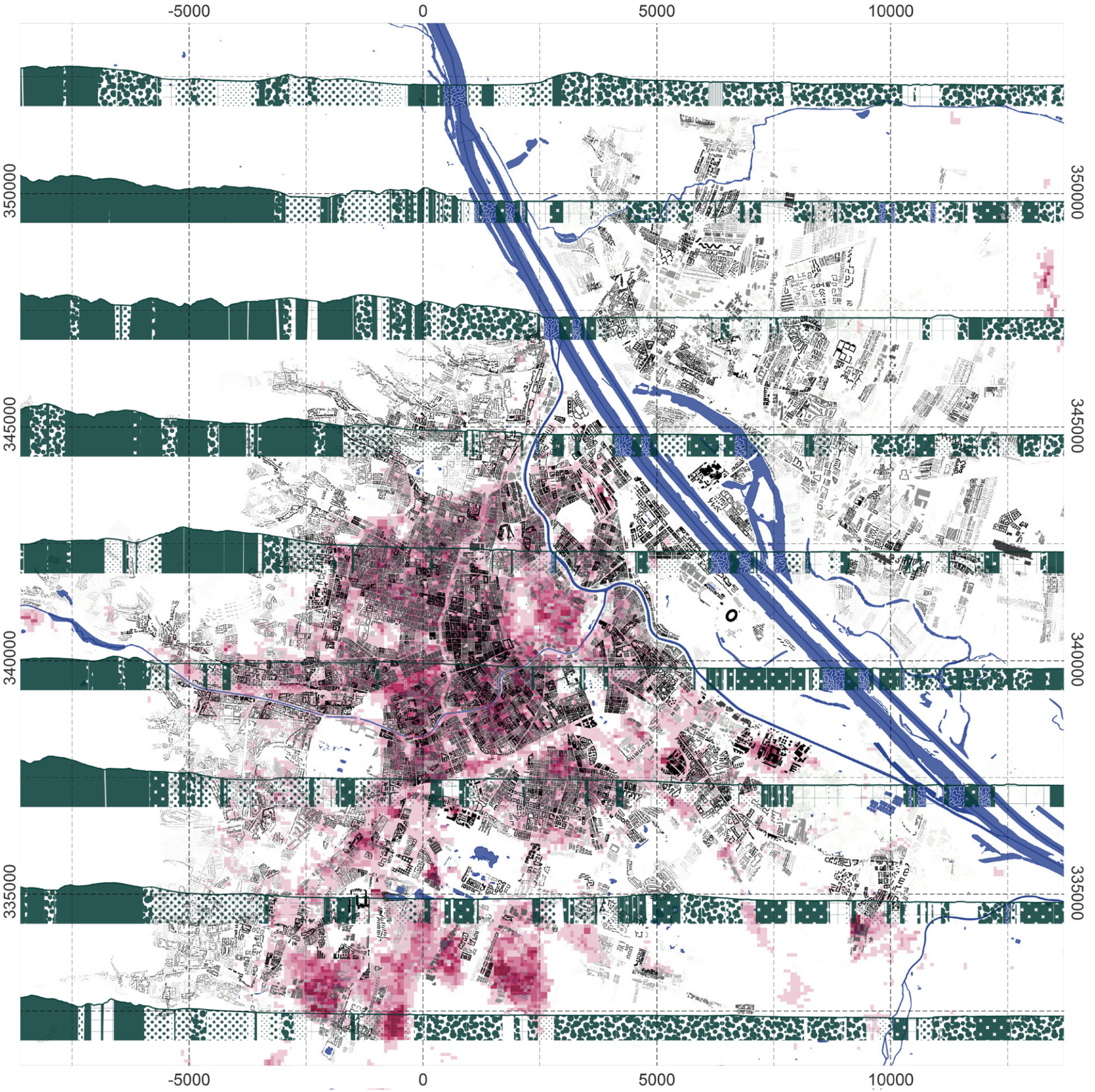
**Notes:**

Population density   Number of residents divided through space of respective plot unit.

LST   Land Surface Temperature (LST) is the temperature of the Earth's surface, typically measured via remote sensing satellites. It measures thermal radiation emitted from the land surface and plays a crucial role in understanding urban heat islands and land cover analysis

**Legend**

| Green Space Typologies | Land Surface Temperature (LST) | Population Density |
|---|---|---|
| Natural areas (forest) | 53-48 °C | > 453 |
| Agricultural used land | 48-47 °C | 266-453 |
| Urban (green) parks | 47-46 °C | 161-266 |
| Low density build areas | 46-45 °C | 100-161 |
| High density build areas | 45-44 °C | 58 - 100 |
| Industrial areas | 44-42 °C | 23-58 |



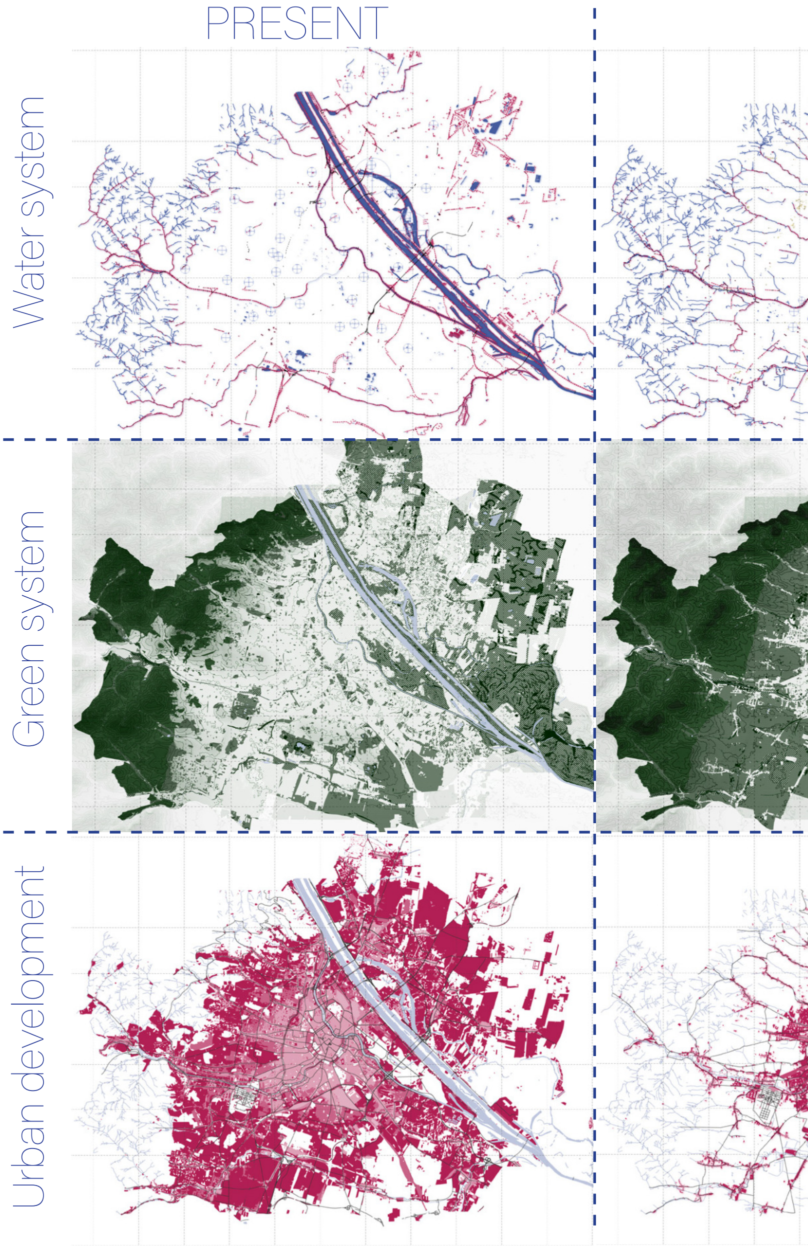

[Fig.16]: LST, population density and green space typologies
*Datasource: EEA 2018, NASA 2023, Stadt Wien 2023, Geofabrik 2023*

# 1.2.3 FRAGMENTATION OF VIENNA'S GREEN-BLUE SYSTEM

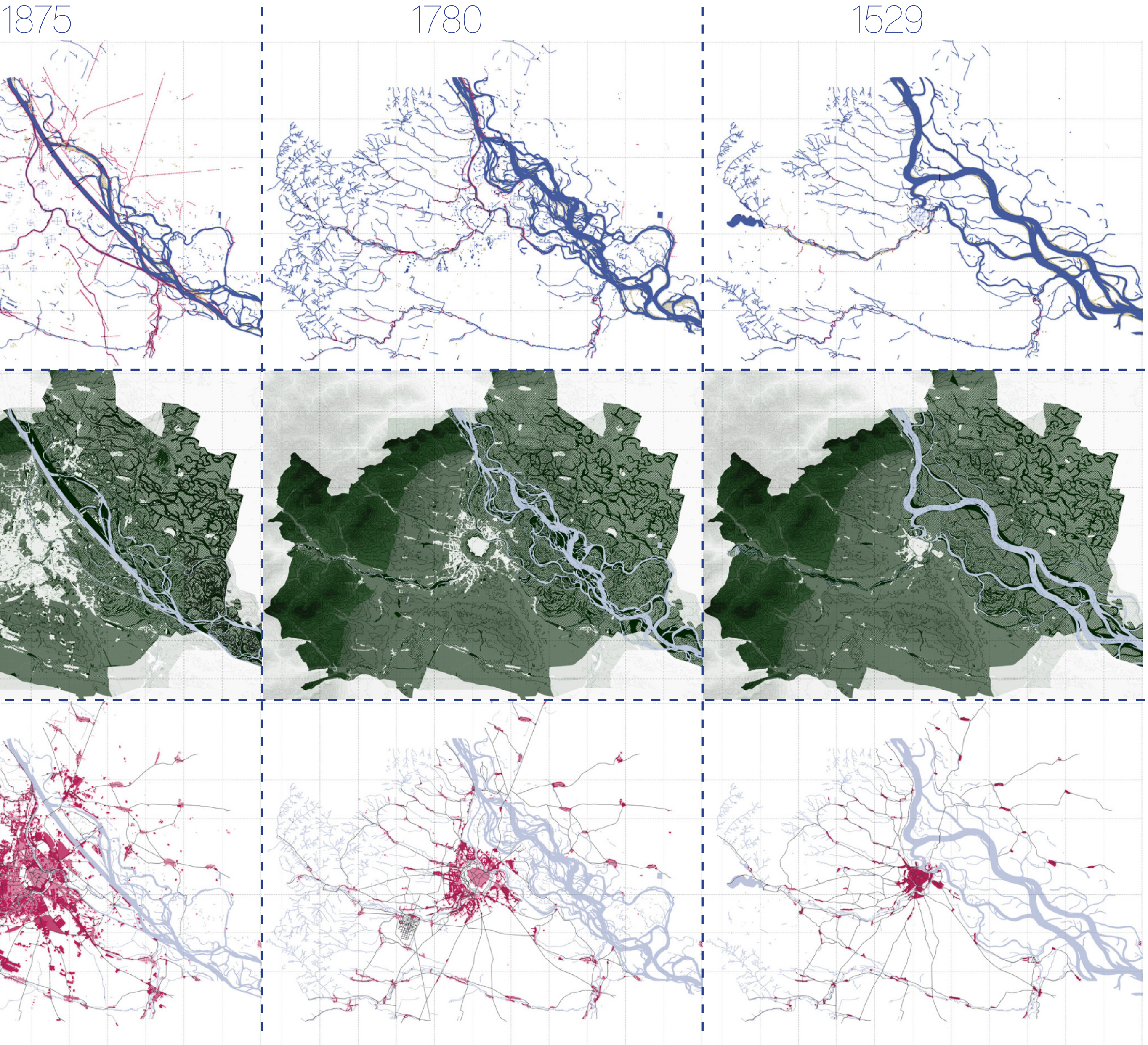
The natural water system of Vienna evolved from a dynamic and extensive water landscape to a regulated and engineered water system, resulting in the fragmentation of the natural system and natural processes.

The Danube River has historically posed both a protective and a challenging barrier to the city's development due to its unpredictable nature and the risk of natural disasters like floods. In addition with the sanitary issues arising from unregulated wastewater disposal into the water streams during industrialization this led to an increasing regulation and the construction of water infrastructure (Figure (17): red in water system) to tame water dynamics (Kugler 2015; Haidvoglet al. 2019).

The green system, characterized by four distinct landscape and soil types, gradually succumbed to the urban expansion of residential areas, especially during the 20th century when cities were restructured to accommodate motorized individual transportation. The ecosystem was nearly entirely displaced, with sporadic remnants preserved as controlled parks for aesthetic purposes. This resulted in a complete dispersion and marginalization of the green-blue system.




[Fig.17]:Historical development of water, green & urban system
*Datasource: Hohensinner et al. 2012-2023,*


1875
1780
1529

Contrasting Vienna's present (urban) landscape with its past reveals the dissapearing green-blue system from the cityscape, documenting a shift toward a fragmented and infrastructural system.

The once expansive waterscape (Figure 22), including the Vienna River and Wienerwald streams, has vanished from the surface. The Vienna River, has once meandered in a wide bed with tributaries and mill streams. The dynamic Wienerwald streams, now concealed within a sewage system, nourished the landscape (Kugler 2015; Haidvoglet al. 2019).

### A | Hernalser Haupstrasse


Natural stream to stream channel...

...to street with covered sewage system.

### B | Vienna River

B 1

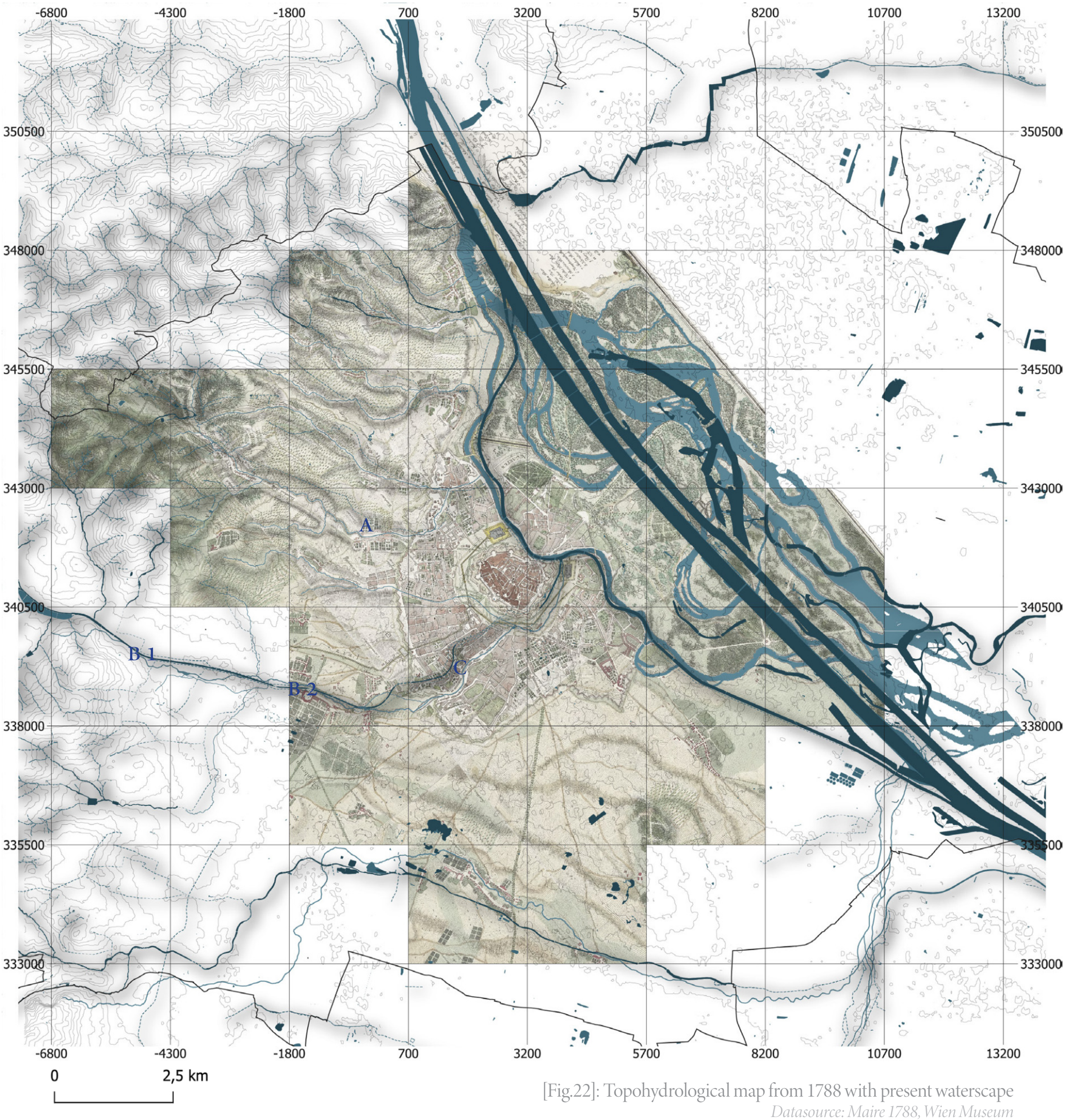
From a natural river bed...

B 2

...to an enclosed canal.

[Above - Fig.18-19]: Hernalser Hauptstraße historic postcard & current state shown from Elterleinplatz
*Source: Stadt Wien 2008*

[Below - Fig.20-21]: Vienna River upstream & downstream (Schönbrunn)



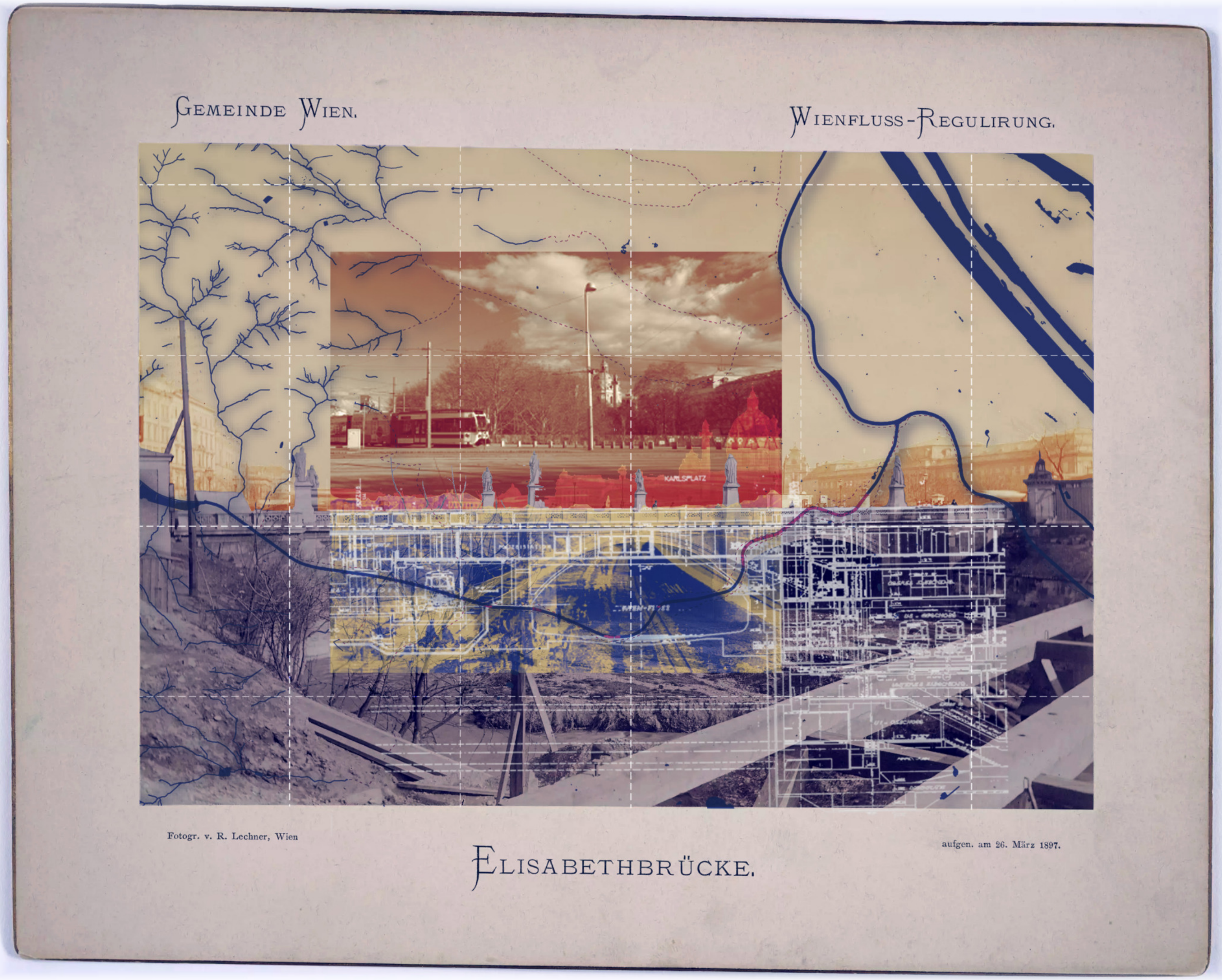

[Fig.22]: Topohydrological map from 1788 with present waterscape
*Datasource: Maire 1788, Wien Museum*

## c | Karlsplatz-Elisabethbrücke

This visualization contrasts the current urban landscape of Karlsplatz with its former state before the regulation of the Vienna River, as depicted in a historic postcard. In the past, the iconic Elisabethbrücke, spanned over the open and natural riverbed of the Wienfluss.

Today, as illustrated in the reddish-coloured image and section, the river is covered and canalized, encased on all sides by infrastructure for mobility and sewage water management. Karlsplatz serves as a crucial mobility hub for both public and individual motorized traffic.

The historical postcard is overlayed with a map of the Wienfluss, highlighting (also in red) the covered sections of the Vienna Canal. Construction of the Wienkanal began in 1894, and although plans originally aimed to cover the Wienfluss up to Schönbrunn Palace, financial constraints prevented full implementation. Currently, approximately 45% of the Vienna Canal is concealed within the infrastructural system (Pollack 2014)




[Fig.23]: Historic-present representation of Karlsplatz-Elisabethbrücke
*Source: Wien Museum, Geofabrik 2023*

## Regulated and marginalized blue-green system

Green-blue infrastructure mitigates heat stress and can store water for dry periods. Following a nature-based approach, the green-blue system also provides habitat and a connecting net for flora and fauna.

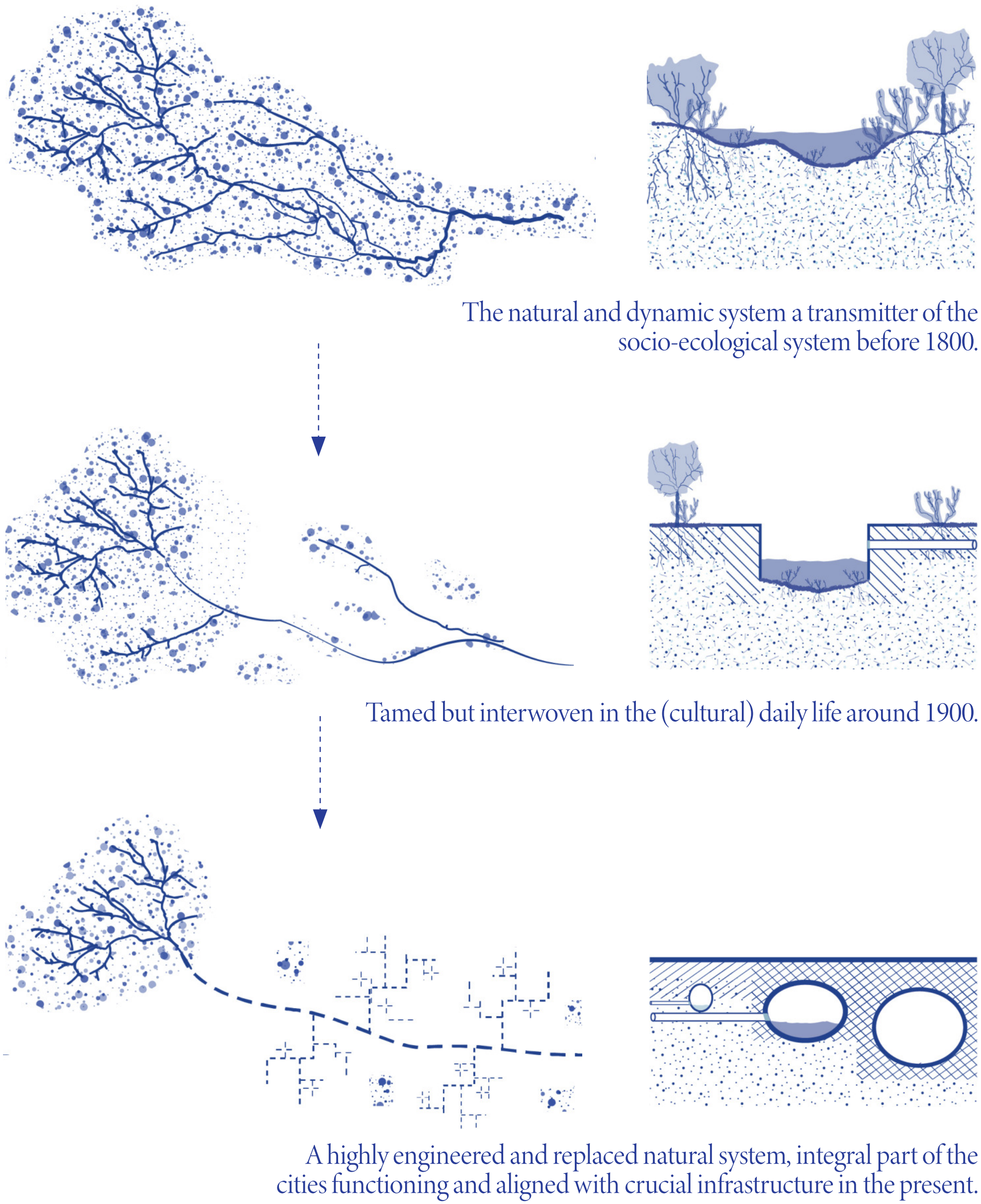
However, although the city of Vienna and its socio-ecological system is influenced by the extensive and dynamic water landscape, by today natural surfaces are fragmented and marginalized through sealing and replacement of ecological resilience through artificial processes.

Out of fear of natural disasters and due to hygienic hazards through mass immigration within industrialization, the natural system became increasingly controlled through a multitude of prevention infrastructures (Haidvoglet al. 2019).

The water system was canalized, resulting in enclosure and concealment of nature. This transformed the natural waterscape of the Danube and the various mountain streams rising from the Vienna Woods into an engineered and often monofunctional infrastructure, serving and providing the base for an engeneered system (Haidvoglet al. 2019).

However, the footprint of the water landscape is still visible in the urban morphology of the city. This and the potential of the water as an interface and transmitter of beneficial socio-ecological dynamics and flows raises the question of reimagining Vienna's green and water system as an access point for a climate-resilient transition.

***Vienna's ecosystem is replaced and marganalized. Is the blue and green system still a potential transmitter of beneficial dynamics and flows for an ecological resilient transition?***




[Fig.24]: Development of Viennas green-blue system

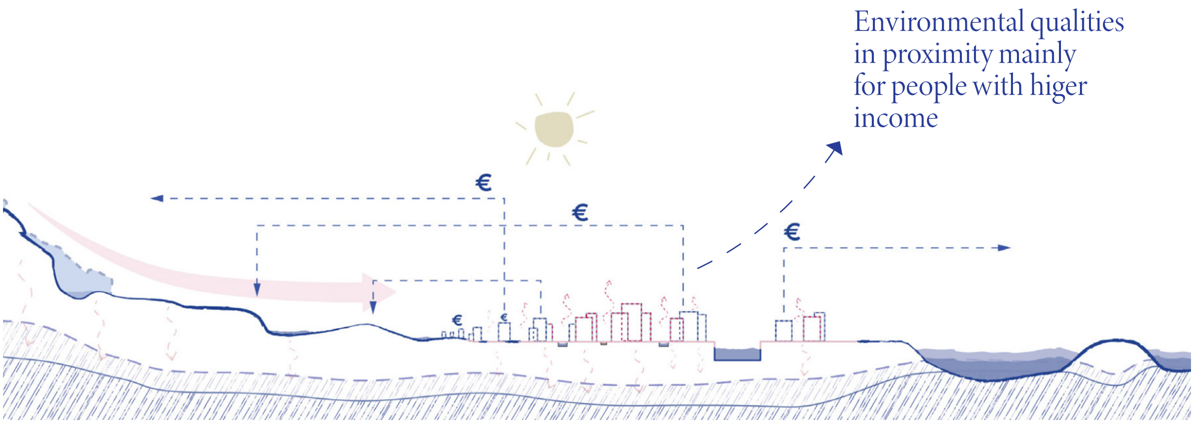
# 1.2.4 Uneven distribution of a surpressed green-blue system

## Uneven distribution of green space

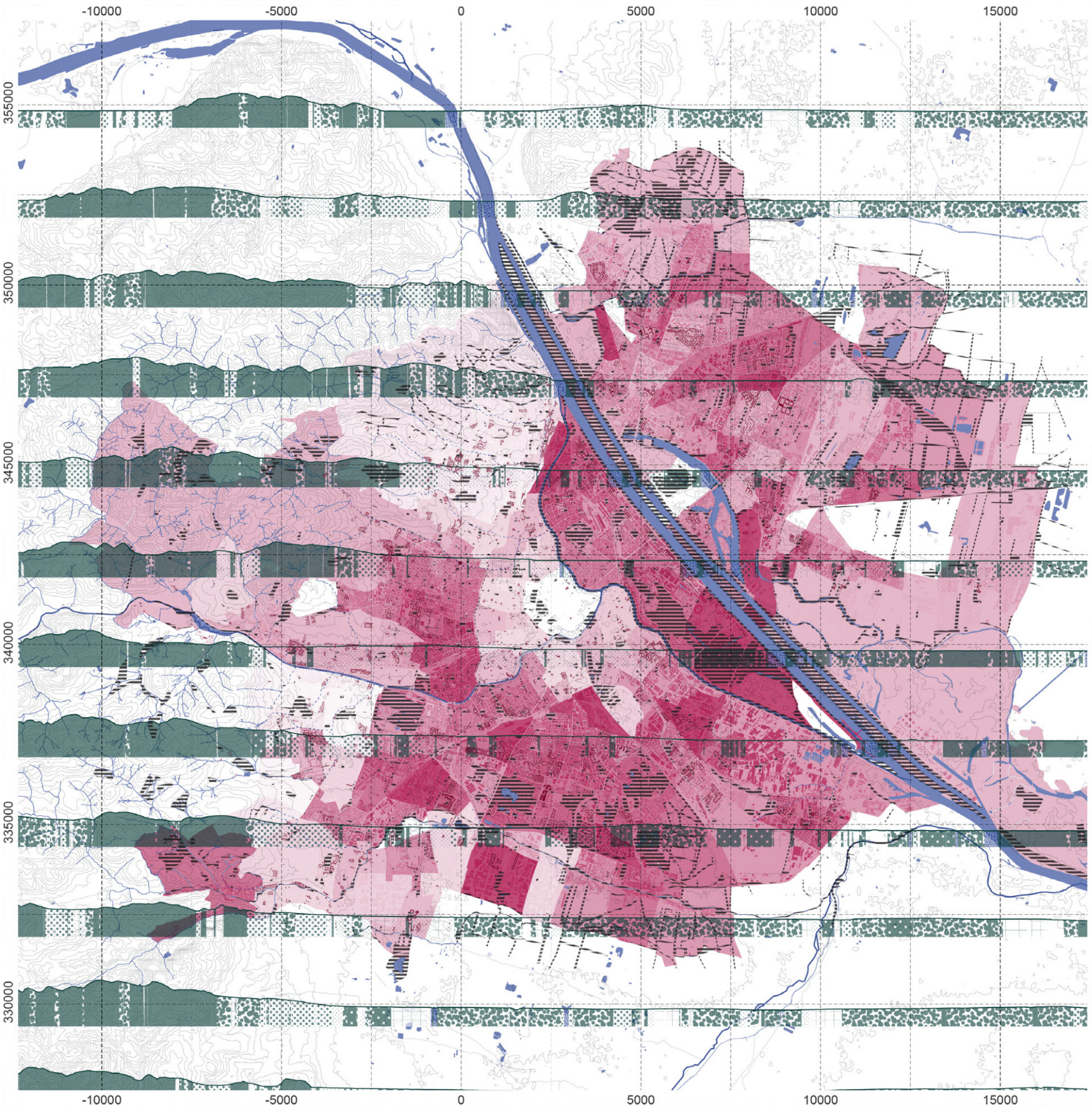
Vienna claims to be one of the greenest cities in the world, indeed 50% per cent of its surfaces are green space. However, the green spaces are unevenly distributed, of this 50% just 31% are publicly accessible and 19% are parks within the city (Stadt Wien Statistik 2023) . Especially in densely populated and low-income areas is a lack of accessible and qualitative greenspace that mitigates heat stress. These people are most vulnerable to climate extremes since escaping to areas with bearable living conditions is often reserved for higher-income households. The lacking ecosystem provision, results in mental and physical distancing to this ecosystems, following limited valuing of the natural landscape and little awareness for the importance of a healthy ecosystem. To achieve a just, climate resilient Vienna there has to be an even distribution of ecosystem benefits.



***The distribution of the green-blue system, a means of mitigating climate extremes such as heat, is uneven. How can we ensure an just transition to climate resilience?***




[Fig. 25]: Access to environmental qualities and amenities based on economic system




[Fig.26]: Subdistricts of Vienna by income with green  land use sections
*Datasource: EEA 2018, AK Wien 2020, Stadt Wien 2023*

# 1.3 Problem statement: Viennas vulnerability to climate extremes

Global temperature, which is rising faster in the Alps than in other European regions, is changing the sensitive ecosystem and the way we live.

Climate change, characterized by erratic weather patterns, coupled with urban development that has historically marginalized the natural ecosystem through suppression, replacement, and fragmentation, exposes the city's vulnerabilities. The rise in temperature endangers the livability of our cities, especially for the most vulnerable of our society.

Vienna is vulnerable due to weather extremes in the form of heat extremes and a rigid urban system resulting in loss of biodiversity and ecosystem services.

## Replaced green-blue system

Vienna's rigid urban system is characterized by its historical approach to managing the natural environment, particularly in terms of water regulation and the extensive sealing of green areas. The over-engineered approach, due to flood prevention and hygienic hazards, transformed Vienna from a water (shaped) city into a water-regulating city, replacing ecological resilience with artificial processes to maintain the system. This and the prioritizing of movement and transformation (Corboz 1983) within cities resulted in a marginalized green-blue system.

## Uneven distribution of ecosystem

The other dimension of the problem is an uneven distribution of ecological services based on a financial and cultural system that provides spatial and environmental qualities and amenities in proximity primarily for wealthy people within Vienna. This results in an increased vulnerability of socio-economic disadvantaged people to the changing weather and climatic conditions, which have limited access to climate mitigating means and the related discourse.

## Detachment to ecosystem

The result is a replaced and marginalized ecosystem in Vienna, especially in social-economic vulnerable areas. The distance to the ecosystem and its services follows a detachment of its citizens and unawareness of the crucial services of nature for the well-being of humans and the socio-ecological system. This and the marginalized ecosystem limits resilience, adaptability and transformation potential.

## New way forward

With the consequences of climate change, we more and more understand the interdependencies of the complex systems present on planet Earth. Realizing this we can no longer only consider the human perspective.

The 20th-century model of urban development has become obsolete and has proven unable to respond to the new demands of the city. Unnecessary hierarchies and inefficient centralization have to be broken up and patterns and systems recombined to transform the city.

Fundamental restructuring, rescaling and reengineering of the current infrastructures will generate the necessary shift in management and practices of green-blue systems and has the potential to reconnect Viennese citizen to and valuing of ecosystem services.


[Fig.27]: Thesis problematization

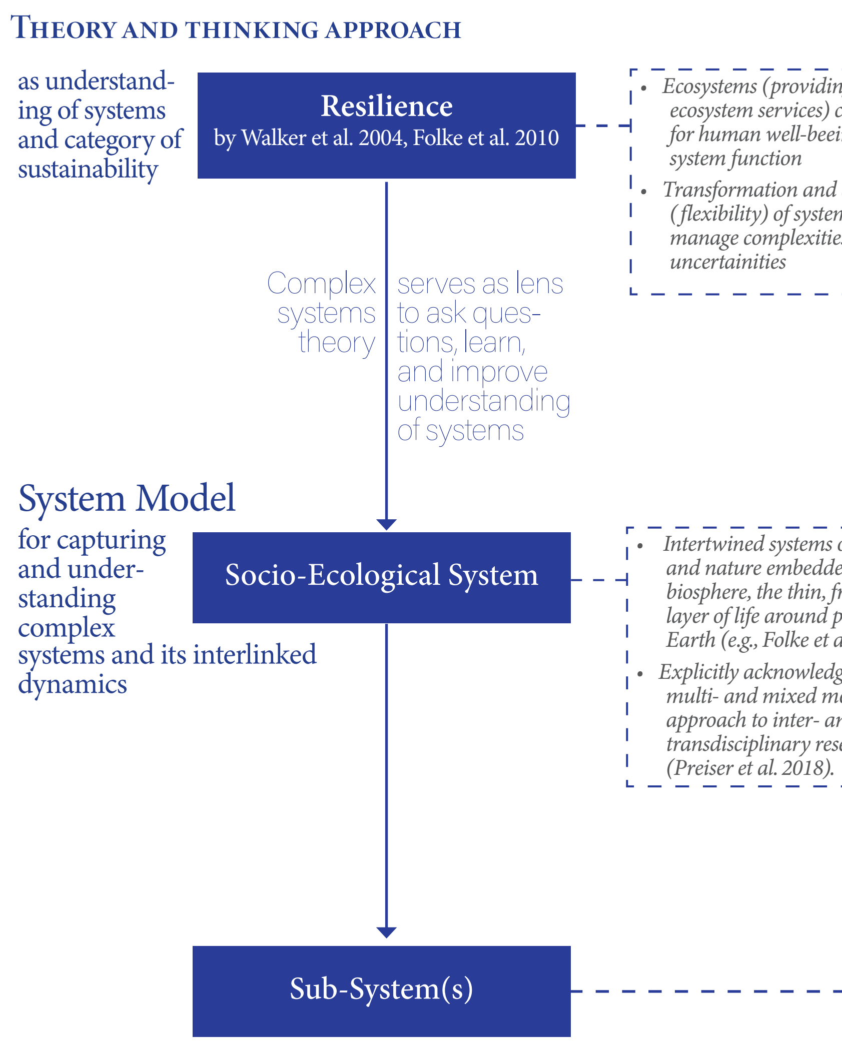
# 1.4 Context: Navigating through resilience theory

The field of resilience theory is extensive and it is easy to get lost in it. There are various definitions and different approaches, which makes it difficult to compare and use in a practical context. It is crucial to define it concisely and choose scholars to orient on.

The emphasis of resilience research used for guidance is on the importance of healthy ecological systems as a foundation for human well-being. Therefore, it is crucial to keep urban environments in balance with healthy ecosystems and reconnect people to the ecological system and its services. To achieve this, a transformation of behaviour towards integrating, valuing and stewardship of ecological systems is needed (Folke 2016). The central question is, how to reconnect people to the biosphere?

The present climate crisis presents major challenges, but also opportunities for adaptation and transformation (Folke 2016).

*Disturbances like the climate or ecological crisis lead to phases of change that open a window of opportunity. The response is, or should be the transformation of systems. That needs a planning approach that considers uncertainty.*



## Types of Resilience

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**General Resilience**
by Walker et al. 2004, Folke et al. 2010

Points to the existence of different self-reinforcing system regimes, and the possibility to shift from one regime to another (e.g. Scheffer et al. 2001)

"Bouncing forward" (ecological resilience) vs. "Bouncing back" (engineered resilience).

*Resilience of what? to what? and for whom?* *(Carpenter et al. 2001)*

**Urban Resilience**

- *Knowledge and understanding of ecosystem processes and dynamics, of natural capital and SE interaction, is the base for resilient cities.*
- *Ecosystem services are a key emergent outcome of social-ecological interactions (Heland and Folke 2014).*

*There is the tendency to become mentally disconnected from the biosphere in urban settings. How to reconnect people in urban environments to the biosphere and essential ecosystem services?*
*(e.g., Gómez- Baggethun and Barton 2013).*

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### Thesis

**Urban Climate Resilience**

**Ecological Resilience**

**Adaptive/ transformative capacity of citizen**

- *"Green spaces and their stewardship is crucial in resilient urban social-ecological systems"* *(Colding and Barthel 2013, Connolly et al. 2014)*

**Specific Recilience**

More concise, as it looks at specific properties and processes of a system and their response to change and pressures (e.g. Walker and Salt 2012).

## 1.4.1 Urban climate resilience: Resilience for what to what and for whom?

Urban climate resilience is defined by Brown et al. (2012) as "the capacity of an individual, community or institution to dynamically and effectively respond to shifting climate circumstances while continuing to function at an acceptable level.

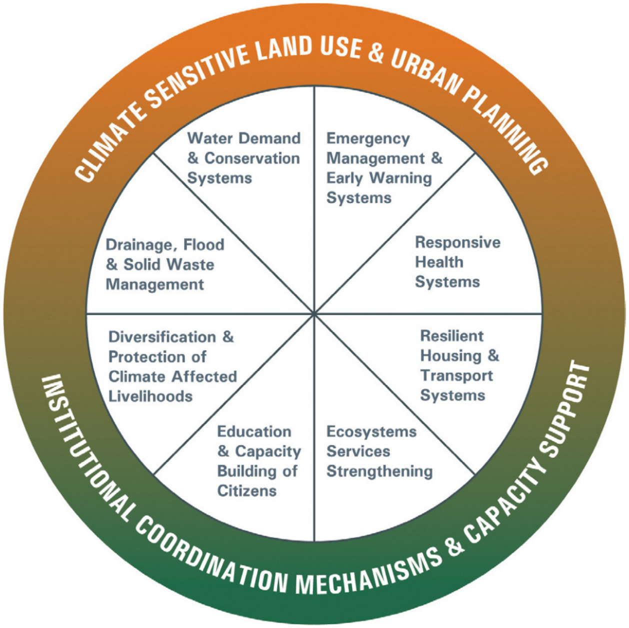
This definition includes the ability to resist or withstand impacts, as well as the ability to recover and re-organize in order to establish the necessary functionality to prevent catastrophic failure at a minimum and the ability to thrive at best. Resilience is thus a spectrum, ranging from avoidance of breakdown to a state where transformational change is possible." (p. 534)

To achieve climate resilient urban social-ecological systems, ecosystems and their stewardship are of crucial importance (Colding and Barthel 2013, Connolly et al. 2014).

### Desired outcomes:

- *capacity building: improved capacity to plan, finance, coordinate and implement climate change resilience strategies*
- *developing a network for knowledge and learning: shared practical knowledge to build urban climate change resilience deepens the quality of awareness, engagement, demand and application*
- *expansion and scaling up: urban climate change resilience is expanded, actors taking action through existing and additional support (finance, policy, technical) (Brown 2012).*






[Fig. 28]: Critical urban climate change resilience action areas (Rockefeller Foundation 2012)

## 1.4.2 Values and characteristics to foster climate resiliency

### Water sensitive design

Water-sensitive urban design advocates for the integration of water-cycle management, protection, and conservation as central components of urban design. It encompasses several core elements:

1. Integration of engineering, environmental, and social science disciplines.
2. Integration of the management of water supply, wastewater, and stormwater.
3. Integration of water management into built forms, including considerations in building architecture, landscape architecture, urban planning, and public art.
4. Integration at various scales, ranging from individual buildings and backyards to street profiles, complete catchment areas, and regional contexts.
5. Incorporation of both structural and non-structural initiatives, spanning from policies to infrastructure development (Wong 2006; van der Meulen, Van Dorst, Bacchin 2023).

This holistic approach to urban design aims to create more sustainable and resilient urban environments by effectively managing and harmonizing water-related aspects across different dimensions of the city.

### Integration and connection of ecosystem services

The guiding principles of the approach revolve around the integration and connection of ecosystem services. The services encompass a range of vital functions, including micro-climate regulation, rainwater drainage for water regulation, sewage treatment, and the provision of recreational and cultural values.

To ensure the effectiveness of the strategy, the priority is on the multifunctionality of services and their seamless integration into the built environment. Emphasis is placed on the connectivity of ecosystems and their alignment with local needs and knowledge (Hansen et al. 2019).

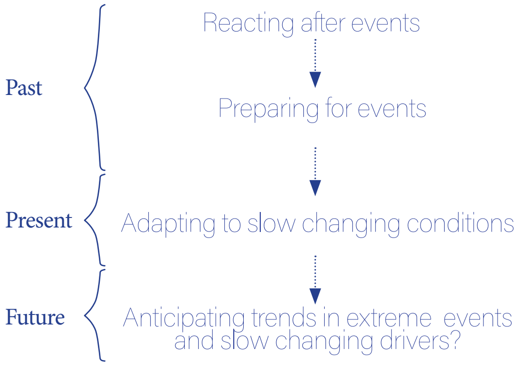
### Fostering awareness and reconnecting people to ecosystem services

A core aspect of the approach involves fostering awareness and re-establishing the human connection to ecosystem services. This is achieved through enhanced collaboration, self-organization, and the incorporation of multiple knowledge systems. The belief is that reconnecting with ecosystem services is essential for sustainable urban development.

In the design framework, space is dedicated for experimentation and learning, recognizing the need for adaptation and co-creation. Stewardship of these ecosystem services is a fundamental aspect, and the importance of direct and slow feedback loops is emphasized to continuously improve and refine the approach. This holistic strategy aims to create urban environments that thrive in harmony with their natural surroundings while nurturing a deeper understanding and appreciation of ecosystem services among the people who inhabit them (Andersson et al. 2019).

## 1.4.2 Planning for adaption and transition

In recent decades, there has been an evolution in planning approaches and how to respond to events such as crises and disruptions (Bloemen et al. 2019).




Netherlands and in particular cities like Rotterdam relying heavily on an engineered system to prevent extreme events and the disruption of their socio-ecological system. Due to increasing climate challanges caused by rising sea level and a depenedency from systemic solutions and resilient pathways, they are frontrunner in terms of climate adaptive research and planning, especially with consideration of the water system (Bilska 2017; Bloemen et al. 2019; Brown et al. 2016), from this Vienna can profit.

The Dutch approach of governing the management of water systems was always based on community involvment and mulit-level governance. This people-centered planning approach ensures increased resilience. Within recent years, there has been a shift in beliefes of how to approach uncertinity of changing natural conditions, from enginereed preperation for events to anticipating by planning for adaption and transformation (Bloemen et al. 2019). Vienna with its traditional engineered approach can learn from the communal based and adaptive Dutch approach.

### Learning from the Dutch for planning for climate resilience

Especially the so called "Delta Program" and Rotterdam's municipal program for climate adaptation (Rotterdams Weerwoord) build frameworks to orientate on for planning for adaption and transition (Bilska 2017; Bloemen et al. 2019, RIA 2020-2022).

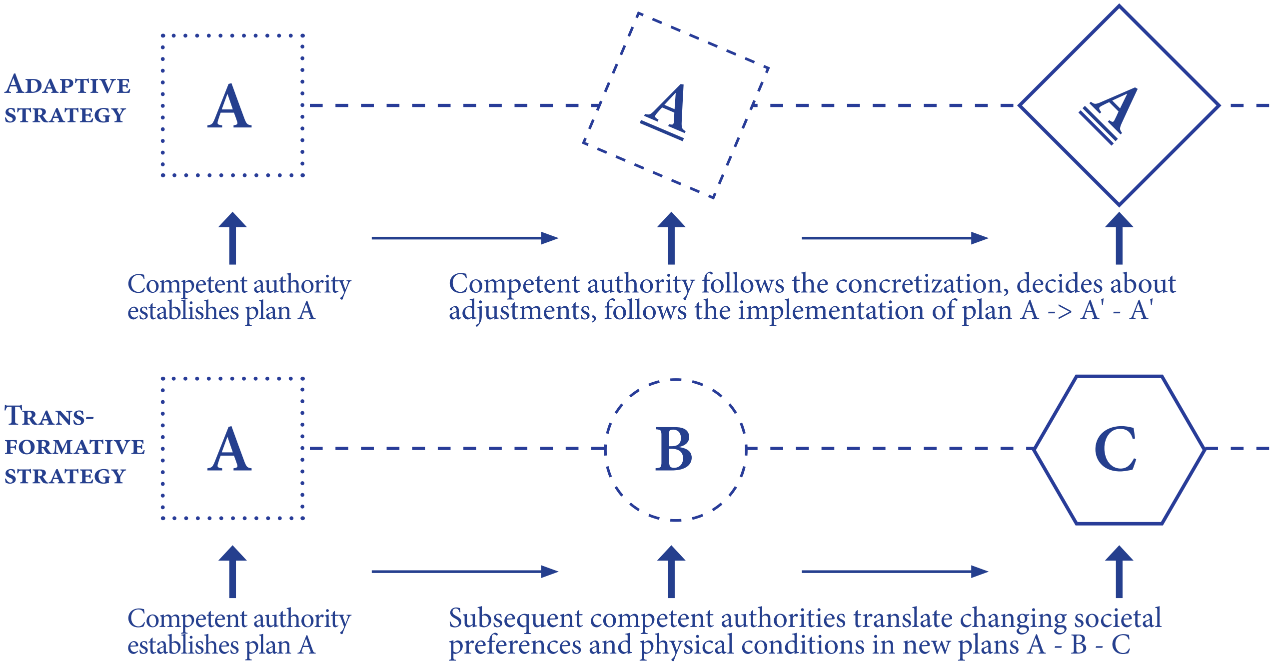
Key components of the "Delta Plan"

- *Taking a systems approach*
- *Involving multiple stakeholders*
- *Adopting a flexible stance in possible strategies (timing of implementation)*
- *Interlinking climatic with societal benefits*

Key components of Rotterdams program for climate adaptation (Rotterdams Weerwoord):

- *Activate diverse societal groups: housing associations, citizen foundations, and private homeowners for collaborative initiatives.*
- *Focus on improving multiple aspects, not limited to climatic concerns.*
- *Safeguard the city by aligning with the priorities and values of the community.*
- *Emphasize understanding what is important for people rather than solely concentrating on climate adaptation (RIA 2020-2022).*

In conclusion, essential is the participation of different societal groups and developing spaces that focus significantly on the social/societal aspects & benefits alongside the technical ones to foster a equitable climate resilience. This approach can be transferred to Vienna.




[Fig. 29]: Adaptive and transformative strategy of planning
*Retrived from: Bloemen et al. 2019*

## Final remarks

There is (1) the need for heightened awareness regarding the necessity of systemic change in response to climate challenges. It becomes evident that the ongoing discourse on climate change compels us to (2) recalibrate our planning approach. It emphasizes the importance of extending our time horizons for strategic planning. With increasing lead times, we must adopt longer-term strategies  The shift from adaptive planning to planned adaptation emerges as a central theme. This transition signifies a proactive stance.

Finally, the significance of (3) seizing opportunities for intervention is highlited, particularly in the realm of infrastructure development. These interventions not only maximize the benefits derived but also enhance flexibility in making decisions that have enduring implications.

| Regime | Restorative redirection |
|---|---|
| Focus | Desired future, imagination, values matter |
| Problem perception | Changes in system/drivers are uncertain, values in dispute, stakes high and decisions urgent |
| Principle strategy | Planned adaptation, foster positive tipping points, transformation, nature-based |
| Governance | Multi-level, strong influence of politics, peer community involvement |

[Fig. 30]: Planning regimes and planning approach
*Retrived from: Bloemen et al. 2019*

## 1.4.3 Sientific and societal relevance: Fostering a societal transition by connecting theory and practice

The necessary transformational processes of our cities "challenge not only our conceptual understanding of what urbanities are but also, crucially, the traditional urban disciplines. The rise in the complexity of urban systems has fueled an ever-increasing fragmentation of expertise skill sets, which is further reflected in the disciplinary fragmentation of academia" (Giseke et al. 2021).

The rising fragmentation of skills and complexity of urban systems has repercussions, with citizens, potential co-creators, finding themselves less represented, and urban processes becoming less comprehensible. This goes against the principles of inclusive urban policies, like communal creation, accessability and social sustainability, as accessibility becomes more challenging for certain groups. Moreover, this fragmentation complicates planning and design, as urban challenges cannot be adequately addressed in isolation from related systems.

In the specific area of study, a design exploration that considers the complexity and interrelation is lacking. Therefore, the climate-resilient metropolis will be examined from an interdisciplinary socio-ecological perspective, exploring urban systems like the water system, ecosystem, social system, and mobility system in relation to each other. The goal is to make the interrelation of these systems and the necessity for change understandable.

The objective is to investigate feasible interventions and establish a framework for the systematic and collaborative climate-resilient transformation of the city. This aims to develop a systematic approach serving as a foundation for co-creative climate-resilient transformations, bringing adaptation and transition planning into practice and empowering citizens.

Technical innovations toward climate resilience and circularity often neglect the underlying, imperative socio-cultural change, identified as a key factor by practitioners (Kirchherr et al. 2018). The social dimension, including a social objective or vision, is frequently overlooked. Other social aspects like spatial justice, quality of life, and participation in the transformation are only marginally addressed (Hempel et al. 2024).

The scientific goal is for climate resilience to become guiding principles, structuring actions across various societal domains, always prioritizing the social good and practicality. This is essential to overcome and realign linear rules, organizational forms, knowledge systems, and, above all, values and goals.

As designers, we often find ourselves, due to our privileged social and educational background, detached from the daily lives of the citizens we plan and design for (Giseke et al. 2021). Closing or bridging the fundamental knowledge and design gap between designers and administrators on the one hand and the population on the other is crucial. Collecting local knowledge and including the community in the collaborative design process are essential.

Climate resilience visions frequently emphasize infrastructural and technical solutions, sidelining social justice and inclusion. This work seeks to rectify this underrepresentation, thus pursuing a societal perspective as a fundament to design for a societal transition.

# 2. Framework and Me

## 2.1 Conceptual Framework

## 2.2 Research question and Fr

## 2.3 Methodology: objectives

# THODOLOGY

## RAMEWORK

## & APPROACH



This chapter delineates the research approach undertaken in the thesis project. It describes the problems addressed and the theoretical foundation for subsequent design explorations. Through this clarification, the chapter establishes the thesis objectives and outlines the trajectory for the remainder of the thesis, thereby enhancing its focus and scope.

# 2.1 Conceptual Framework: Objectives & Framing

This chapter clarifies the conceptual frame of my thesis. It systematicly presents the point of focus and access point of my thematic/ theoretical research. It represents the interface of theoretical values & trade-offs as well as descriptive analytical approach.

## Climate Resilience

Climate resilience refers to the adaptability and transformability of the urban system to withstand disturbances related to climate challenges while maintaining acceptable function. It means the capacity of individuals and communities to dynamically and effectively respond to shifting climate circumstances and the ability to re-organize to prevent catastrophic failure. Achieving climate resilience is based on the belief, that functioning and healthy, or resilient ecosystems as part of the socio-ecological-system (SES) are necessary to contain human well-being and foster transformability & adaptability of the complete SES (Folke 2016).

## Environmental Justice

Environmental justice refers to the equitable distribution of ecosystem services in urban areas, which are crucial for climate resilience. It highlights the need for green-blue spaces that are accessible and usable to all individuals and emphasizes participation and inclusive decision-making. This ensures social and health benefits as well as the recognition of the diverse needs, values, and preferences of all actors, fostering resilience (Łaszkiewicz et al. 2022; Kabisch & Haase 2014).

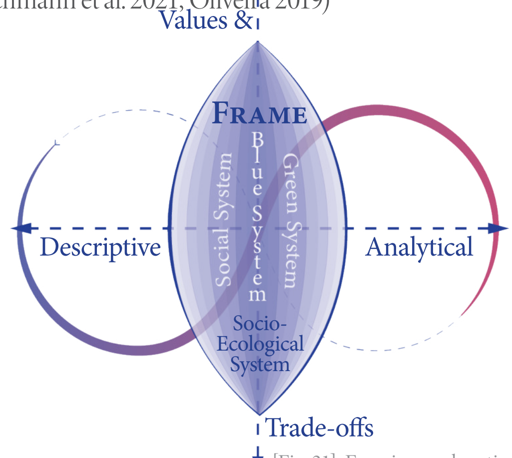
To address climate extremes, encourage attachment to nature, and promote ecosystem stewardship, we must strengthen green-blue spaces, especially in proximity to marginalized groups (Anderson et al., 2019; Haase 2014).

## Blue & Green System

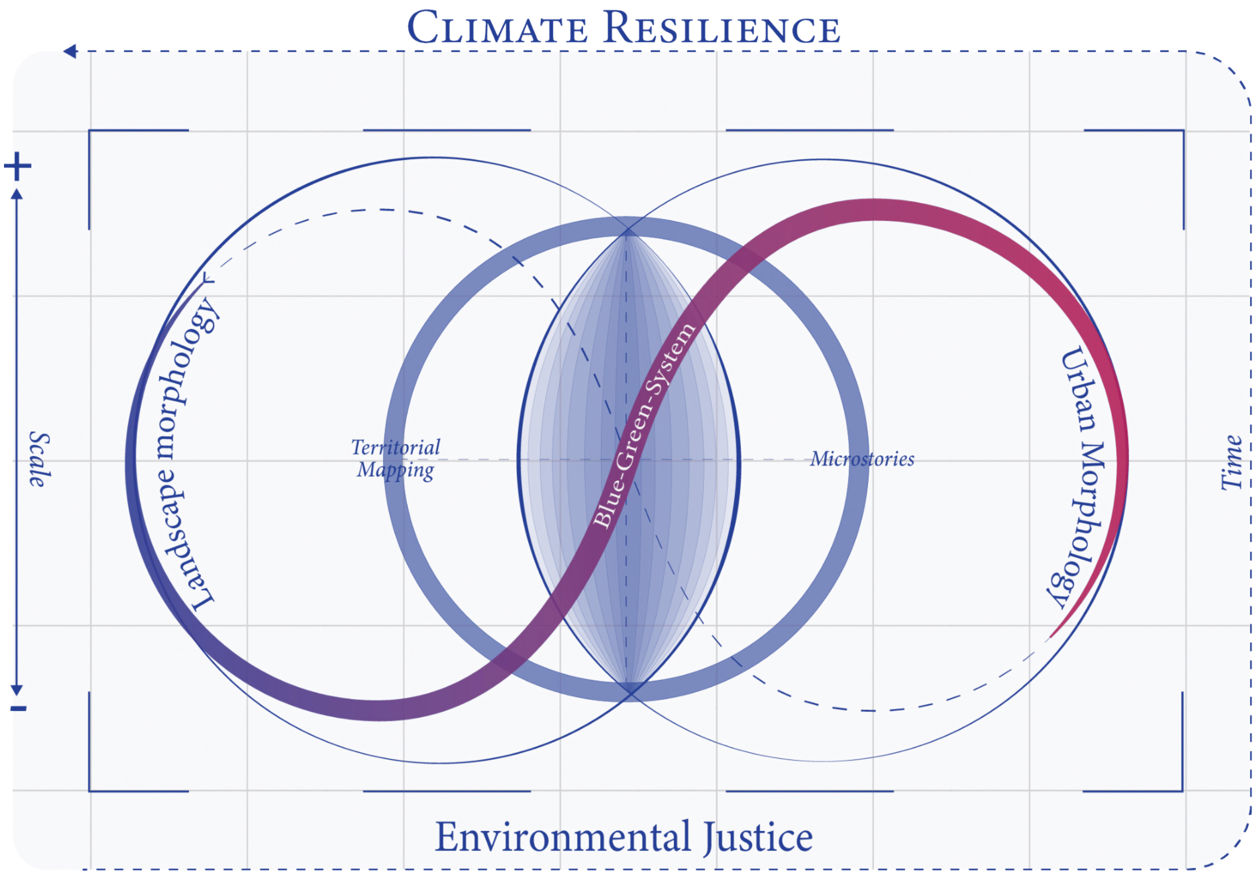
The water system (blue system) is an integral component of the metabolism of the socio-ecological system (SES). It is essential to recognize that the water system cannot be viewed in isolation. Instead, it is intricately linked with the green system, encompassing vegetation, soil, and their inhabitants. These areas play a vital role in supporting diverse ecosystems, its services, and delivering social benefits. Consequently, the green & water system is deeply intertwined with the social system, which has both shaped and continues to influence the nature of this interconnected system (Gunderson & Holling 2002; Langemeyer & Connolly 2020).

## Urban Morphology

Urban morphology directs to the structure and characteristics of the built environment. It provides insight into the interplay between human influence in shaping the landscape and the reciprocal impact of the green-blue system. This system, once viewed as entirely natural, is now recognized as being shaped and managed by human activity, influencing the dynamics of the social system (Andersson et al. 2019; Fleischmann et al. 2021; Oliveira 2019)




[Fig. 31]: Framing explanation



[Fig. 32]: Conceptual Framework

## Landscape Morphology

Landscape morphology has a direct influence on water movements, soil, physical and chemical properties, and on the productivity of the vegetation cover. In human geography it is the material formation of the landscape, its shaping and reshaping, in which social structures and cultural worlds are enfolded (Mayhew 2009).

Reconstruction and understanding of the original natural landscape, through historical geographical research capturing mans activity and impact. Division of form into natural and cultural landscape is the necessary basis determining the areal importance and character of man's activity and the landscape's identity, determined by man (Sauer 1925).

## 2.2 Research question & Framework: Objectives, research and theoretical frame

# HOW CAN A *JUST* *CLIMATE RESILIENT* TRANSITION IN V
# BE FOSTERED BY *REIMAGINING* THE *GREEN-BLUE SYST*



### RQ1 Conceptual frame:
climate resilience transition

How are spaces and systems that influence a climate resilient transition identified?

Just transition

What are methods to ensure an enviromentally just transition of the green-blue system with benefits for all actors?

### RQ2 Analysis:
access points within Socio-ecological system

How can the landscape and urban morphology disciplines help to unfold and design the green-blue system as part of the socio-ecological system towards benefits in heat mitigation and increased climate awareness?

- What is and was the role of the green-blue system of Vienna and how do other systems interrelate?
- What are constraining factors in Vienna due to engineered resilience and vulnerability, in light of a heat mitigating nature-based infrastructure?

### RQ4: Design
Reimagining the green-blue system

How can the green-blue system be reimagined in Vienna for a climate resilient system?

Research by Design

# VIENNA

## EM?

### *Climate resilient transition*

Climate resilience entails a transformative shift in urban systems, that replaces ecological resilience and simultaneously constraining the livability of its inhabitants. This transformation necessitates the incorporation of resilient ecosystems and their integral role within the urban framework.

To achieve climate resilience, a fundamental shift in the governance and management of urban ecosystems becomes imperative. This shift promotes the seamless integration of ecosystems into the built environment and necessitates a transformation in our understanding and valuation of ecosystems and their services. This transformation acknowledges the vital role of ecosystem services in human well-being and recognizes their intricate interdependencies within the biosphere (Folke 2016).

### *Just transition*

A just transition refers to a focus on social-economic marginalized areas, which are currently most vulnerable to climate change. This fosters a fair distribution of means and systems, in this case, accessible and usable ecosystems for all individuals and actors, to mitigate heat extremes, water shortage and biodiversity loss. Additionally, they function as a knowledge system for a social transition towards more climate resilience, enhancing awareness and valuing.

### *Green-blue system*

The water system consists of the natural water system shaped by landscape morphology and cycles of time, as well as, its shaping by man and the built environment. There is the infrastructural dimension and the natural dimesion of the water system, which overlapping is somehow blurry. However, both are considered as part of a transformative design process.

The water system is part of the socio-ecological system and therefore deeply interlinked with the built environment, ecological network and the social system.

### *Reimagining*

The water and green systems serve as pivotal entry points for the transformation process. Reimagining these systems involves the potential reconfiguration and seamless integration of a waterscape, drawing inspiration from historical natural conditions. It entails the reintroduction of a green-blue infrastructure within the built environment and the unsealing of surfaces, which inherently brings along a host of social and ecosystem services.

This transformation signifies a shift from a previously repressed and controlled approach to a co-productive, water-sensitive, and nature-based paradigm.

## 2.2.1 Research questions: Aims, Methods, Outcomes

### Conceptual frame:
Rigid urban systems

**RQ1.1** How are spaces and systems that influence a climate resilient transition identified?

### Aim

Clarifying a method to identify systems needing transformation or stuck in systemic deadlocks. This method not only pinpoints such systems but also provides opportunities for intervention, pinpointing entry points while avoiding unsustainable paths. It should comprehensively address the urban system in both time and space.

Just climate resilience

**RQ1.2** What are methods to ensure an enviromentally just transition of the green-blue system with benefits for all actors?

Evaluating and identify methodical and spatial approach that fosters environmental justice for all inhabitants of the urban green-blue system.

### Analysis:
access points within SES

**RQ2.** How can the landscape and urban morphology disciplines help to unfold and design the water system as part of the socio-ecological system towards urban climate resiliency?

Analytical design investigation of how are landscape morphology and urban morphology of Vienna interrelated with focus on the water system to identify access points for a climate resilient transition.

**RQ2.1** What is and was the role of the green-blue system of Vienna and how do other systems interrelate?

Exploring and comprehending Vienna's green-blue system and its reciprocal impact on the urban system, while also considering how the urban system influences the water system across different temporal and spatial scales, considering both objective and subjective perspectives.

**RQ2.2** What are constraining factors in Vienna due to engineered resilience and vulnerability, in light of a just climate resilient transition?

Indentifiying and localizing rigidity and poverty traps in Vienna spatially and socially, that are typical urban landscape patterns to follow a systematic design approach. Setting them in relation with actors and governance system.

### Design
Transforming the water system

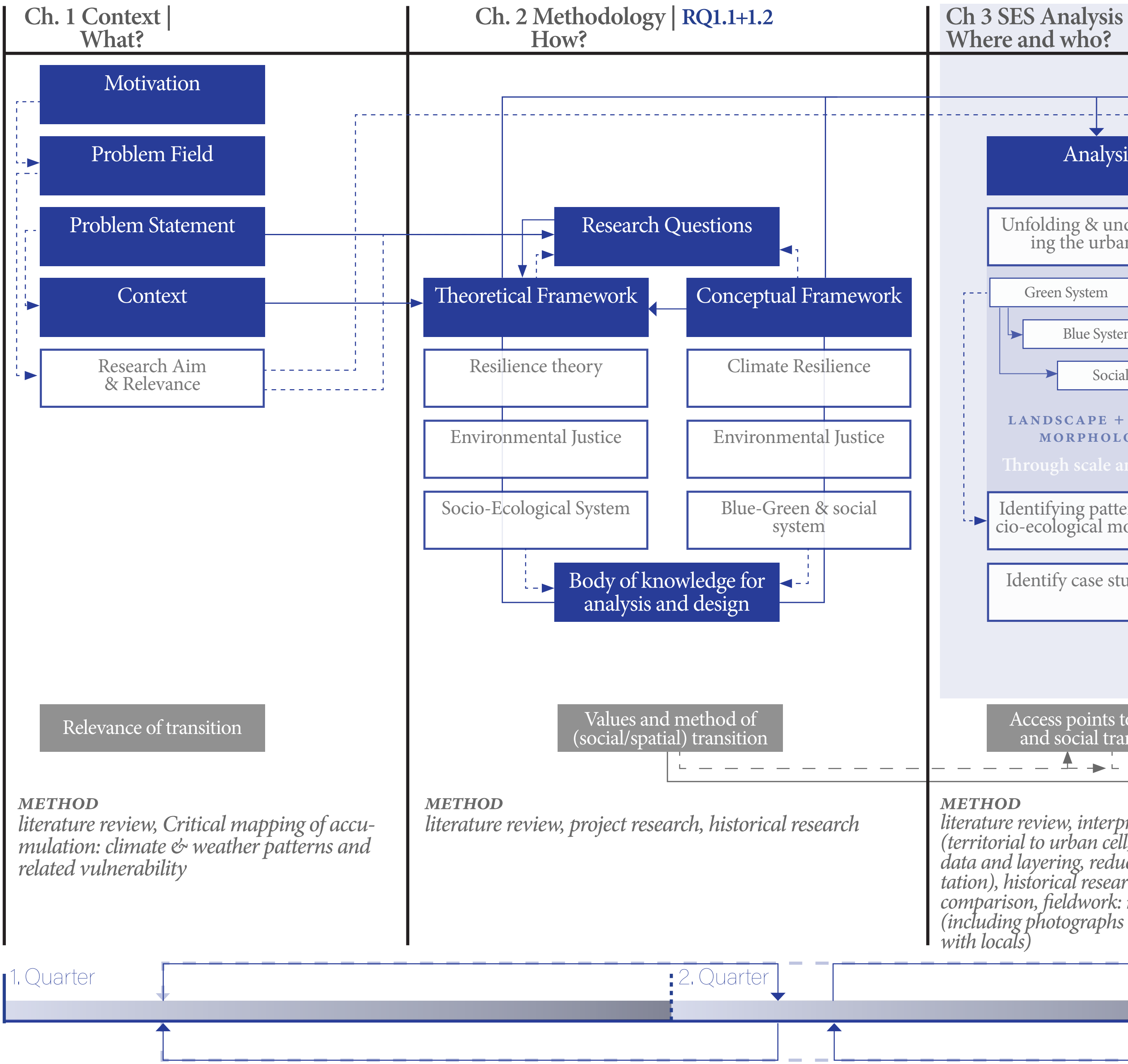
**RQ3.** How can the green-blue system be reimagined in Vienna for a climate resilient urban system?

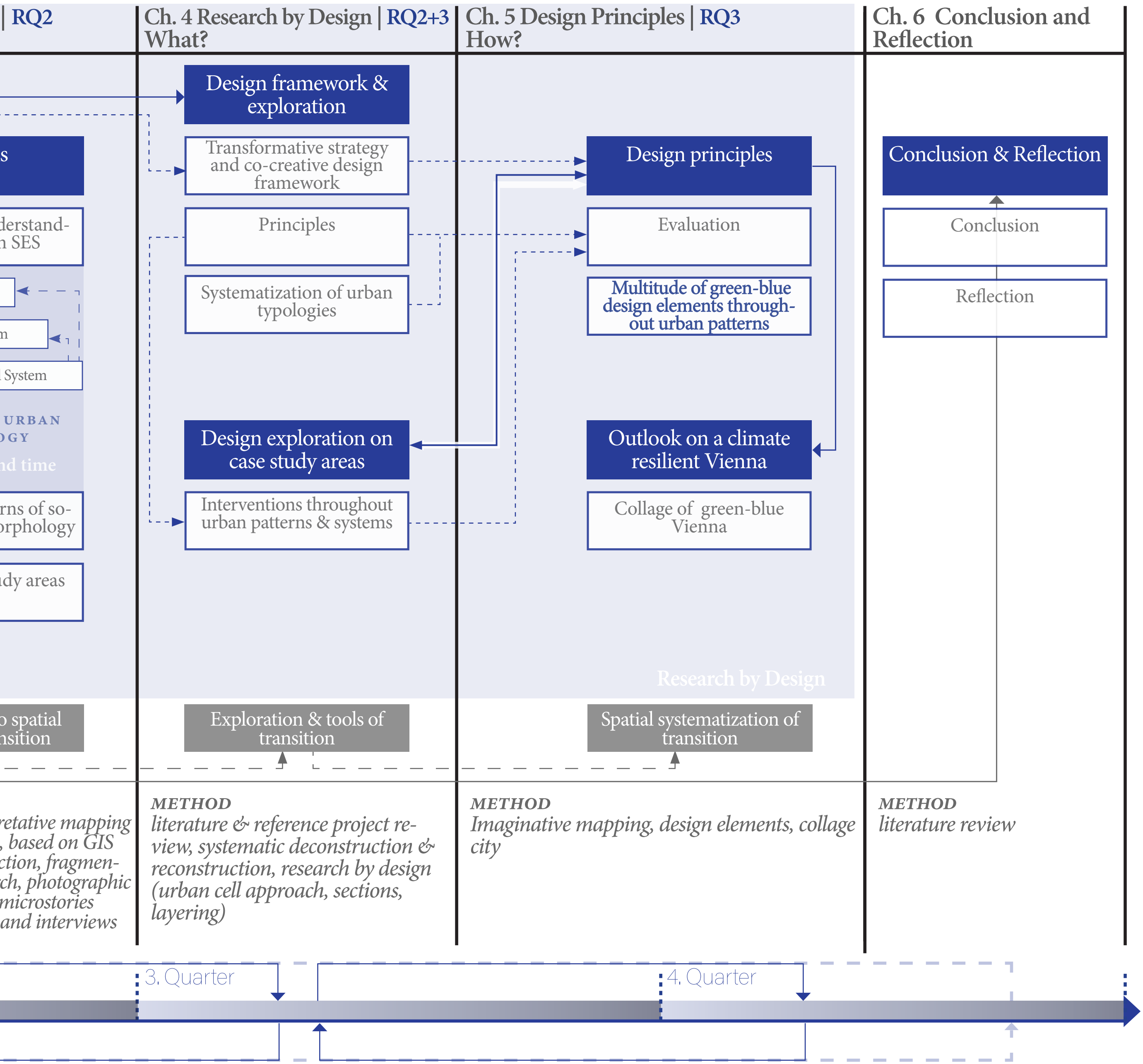
Development of design interventions througout scale to comprehend the reimagination of the green-blue system and its interdependencies with related systems and agents. Based on patterns, considering the net and the nodes of the system, devleopment of an metropolitan outlook for Vienna.

| Methods | Outputs |
| --- | --- |
| Literature review, historical research, Project review | Framework for interpretative mapping of territory and systems throughout time and scale for a systematic design. |
| Literature review, project review | Catalogue of systems and their spatial characteristics, that influence the effect of climate extremes in urban environments, indicating their utility as tools for the analysis and design phase.<br>Text and scheme of systems that are interrelated with the water system for a climate resilient transition.<br>Catalogue of planning approaches, services and spatial characteristics, that create attachment and valuing of ecosystems. |
| Design exploration, literature review | A design investigation that describes the socio-ecological system of Vienna and its development comprehensibel througout scales. First, by unfolding and comparing system by system over time and secondly by overlapping essentials to discover rigidity traps. Thereby unfolding access points and systematization of patterns.<br>Outputs are territorial maps and sections, neighbourhood scale maps and sections in relation with pictures, systemic maps of blue-green and social structure, catalogue of morphological patterns of change over time. |
| Interpretative mapping through time and scale, based on historical research, territorial mapping, GIS data, in relation to the urban cell, photographic research and microstories. | |
| Systematizing patches retrieved from landscape morphology/ecology and urban morphology, based on hydro-ecological and urban morphology patterns and socio-economic dynamics. Stakeholder analysis | Catalogue of typical urban patterns to follow a systematic design approach, categorized in the net and the nodes.<br>Exemplary case study areas, as base of a design investigation.<br>Stakeholder analysis that relates interventions to agents and planning systems to increase capacity for a transformation. |
| Systemic design (pattern language), Assessments of designs, critical reflection on use of patterns on applicability, transferability and exclusion<br>Vision/ Scenario building | Design principles as recommended design interventions as well as systematization, abstraction and communication of the transitioning system, essential patterns that enable spatial and social qualities for a just climate resilient city.<br>Adaptable/ flexible metropolitan vision that shows the socio-ecological system and its transitioned system in the overall context within time. |

Research by Design

## 2.2.2 Research Framework




| RQ2
Ch. 4 Research by Design | RQ2+3
What?
Ch. 5 Design Principles | RQ3
How?
Ch. 6 Conclusion and Reflection
Design framework & exploration
Transformative strategy and co-creative design framework
Principles
Systematization of urban typologies
Design exploration on case study areas
Interventions throughout urban patterns & systems
Design principles
Evaluation
Multitude of green-blue design elements throughout urban patterns
Outlook on a climate resilient Vienna
Collage of green-blue Vienna
Conclusion & Reflection
Conclusion
Reflection
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rphology
dy areas
Research by Design
o spatial
nsition
Exploration & tools of transition
Spatial systematization of transition
retative mapping
, based on GIS
ction, fragmen-
ch, photographic
microstories
and interviews
METHOD
literature & reference project review, systematic deconstruction & reconstruction, research by design (urban cell approach, sections, layering)
METHOD
Imaginative mapping, design elements, collage city
METHOD
literature review
3. Quarter
4. Quarter

## 2.2.3 Theory and reference framework

### Ch. 1 Context | What?

**General Resilience**
- Folke 2010, Folke 2016, Walker et al. 2012, Peterson et al. 1999

**Complex systems**
- Gunderson and Holling 2002

**Complex adaptive systems**
- Levin 1999, Scheffer et al. 2001

**Socio-ecological systems**
- Berkes and Folke 1998
- Ostrom 1999,
- Langemeyer and Connolly 2020

**Urban climate Resilience**
- Brown et al. 2012

**Urban resilience in practice**
- Andersson et. al 2021
- Hempel et al. 2024

**Planning for adaptability**
- Bloemen et al. 2019
- 

### Ch. 2 Methodology | RQ1.1+1.2 How?

**Environmental justice**
- Kabisch and Haase 2014
- Calderón-Argelich, Benetti, et al 2021

**Landscape Morphology**
- Mayew 2009
- Sauer 1925
- Furia 2022

**Urban Morphology**
- Oliveira 2019b, Andersson et al. 2019, Fleischmann et al. 2021b

**Palimpsest**
- Corboz 1986

**Method Projects**
- Antwerp, Territory of a new modernity, Secchi, Vigano
- Antwerp Vision, De urbanists
- Woluwe Waterland, fallow

**Method**
**Research by design**
- Viganò, P. 2014, 2016
- Etteger van and Raaphorst 2021
- Prominski 2016

**Interpretative Mapping**
**Landscape urbanism**
- Corner, 1999, 2011;
- Shannon 2004,
- Allen 1998
- Waldheim 2016

**Water Urbanism**
- De Meulder 2002-2012
- De Meulder & Shannon 2013

### Ch 3 SES Analysis Where and who?

- Haidvogl et al. 2019
- Simperler et al. 2018
- Ring et al 2021

| RQ2

## Ch. 4 Research by Design | RQ2+3 What?

**Planning blue-green infrastructure**

- Hansen 2019

**(Storm)Water Design in practice**

- Prominski et al. 2017
- Officials 2017
- Russo et al. 2023
- Slaney 2017
- Steenbergen 2008)
- UNaLab 2019
- World Bank 2021
- Zumsteg et al. 2016

## Ch. 5 Design and Strategy | RQ3 How?

- Rowe 1994

## Ch. 6 Conclusion and Reflection

- Giseke et al. 2021
- Hempel et al. 2024
- Rowe 1994

## 2.3 Methodology: objectives & approach

| Body of knowledge | Research question |
|---|---|
| Landscape Urbanism<br>Water Urbanism<br>Urban Design | In light of a rigid urban system that supresses equal distribution of ecosystem services, how can a just climate resilient transition in Vienna be fostered by transforming the water system? |
| **Goal** | **Methodology** |
| Environmental just transition towards climate resiliency, by offering systematized spatial solutions for integrating the water system in the built environment and accessible knowledge systems to foster valuing of ecosystems. | Interpretative mapping<br>Research by design |



To understand and investigate the urban socio-ecological system, in particular the water system, and its shifting relations between landscape, settlements and water infrastructure, different bodies of knowledge for a methodological approach are oriented.

### Landscape Urbanism

In urban design and planning, landscape design as an approach to dealing with environmental challenges has taken a central role.

Within landscape urbanism principles from ecology, especially natural systems evolving and the theory of feedback loop disturbance within the adaptive cycle, were used as design strategies (Waldheim 2006, 2016).

LU was developed as an interpretation of settlements structured *'according to hydrological regimes and topographical variations'* and a viewpoint to arrange new settlements with natural systems to *'work with, rather than against, the forces of nature'*. It emphasises where to build as much as where not to build (De Meulder and Shannon 2010) by *'providing context-responsive solutions grounded in local knowledge'* (Bernal, De Meulder, Shannon 2020).

Therefore, it is offering tools for understanding and representing the dynamic landscapes of our world and how these change and evolve with culture through interpretative mapping and research by design.

Natural crises and disasters are key elements in understanding this relation, these are reasons for the emergence of water urbanism as a domain within landscape urbanism (Bernal, De Meulder, Shannon 2020).

## Water Urbanism

Water Urbanism recognizes that water systems have historically shaped entire territories and suggests that this understanding can be reintegrated into modern urban planning (Shannon, De Meulder, D'Auria, & Gosseye, 2008). It proposes a shift towards employing 'soft engineered' strategies and 'polytechnic infrastructure' that serve multiple functions, such as flood control, supporting aquatic life, enhancing biodiversity, and providing recreational spaces. This approach contrasts with the monofunctional, centralized, and linear water infrastructure typical of modern pipe engineering practices, which have proven inadequate (Shannon, 2013; Bernal, De Meulder, Shannon, 202). By adopting these strategies, Water Urbanism aims to enhance water capacity and circulation within urban areas while promoting resilience to climate change.

*"Water Urbanism's ambitions are to contribute to a base of the city, the city where at least the water issues are dealt with in a natural, integrated and socially just way" (De Meulder & Shannon, 2013:7)*

Water Urbanism adopts a holistic approach that considers both social and physical infrastructures alongside hydrological systems. It challenges conventional planning practices that isolate elements of an urban system and instead starts with the assumption of a jointly built and natural environment within which all species operate.

*These complex, interrelated issues require a design-driven, integrative, and systems-based approach, rooted in a deep understanding of social dynamics, political context, and spatial thinking.*

Concepts such as 'sustainable urban drainage systems,' 'water-sensitive urban design,' and 'nature-based solutions' are integral to the practice of water urbanism and are employed in the further design investigation.

## Overview

### Theory

**Climate resilience** Folke 2016, Brown et al. 2012
**Environmental justice** Kabisch and Haase 2014
**Socio-ecological systems** Gunderson and Holling 2002, Langemeyer and Connolly 2020

► Spatially:
**Landscape morphology/ecology** Mayew 2009, Sauer 1925
**Urban morphology** Fleischmann et al. 2021b, Kabisch und Haase 2014, Andersson et al. 2019

### Body of knowledge for approach

**Landscape Urbanism** Waldheim 2016
**Water Urbanism** De Meulder/Shannon 2020, Bernal 2022
**Urban Design:**

- Water sensitive urban design (WSUD) van der Meulen, van Dorst, Bacchin 2023
- Nature based solutions (NBS)
- Sustainable urban drainage systems (SUDS)

### Methods

**Interpretative mapping** (Corner 1999, Secchi, Vigano)
**Research by design** Viganò/ Secchi 2014, 2016; Etteger van and Raaphorst 2021, Prominski 2016

- Case studies
- Design principles

## 2.3.1 Design Framework: Method of mapping and design

Design, as Vigano (2016) states, serves as a method for comprehending reality, particularly in complex and uncertain contexts. Vigano identifies three fundamental ways through which design generates knowledge: "abstraction and conceptualization", "description", and the formulation of future hypotheses (Vigano 2016:13). Importantly, design doesn't exist in isolation; it translates and refines initial concepts from various disciplines (Vigano, 2016).

Mapping, as articulated by Corner (2011), becomes a transformative instrument that unveils new realities and reshapes existing ones rather than merely mirroring them. It empowers by uncovering hidden potentials and expanding horizons.

### Interpretative mapping

In this thesis, interpretative mapping, a design-driven, integrative, and systems-based method, is applied. Grounded in a deep understanding of social, political, and spatial aspects, it reveals and establishes relationships with situations (Vigano, 2016:13).

> *"Interpretative mapping is a first step towards the transformation of the territory. An understanding of the context and the reading of the sites (...) and relate to the particularities of place and situations" (Shannon, 2008: 105,106).*

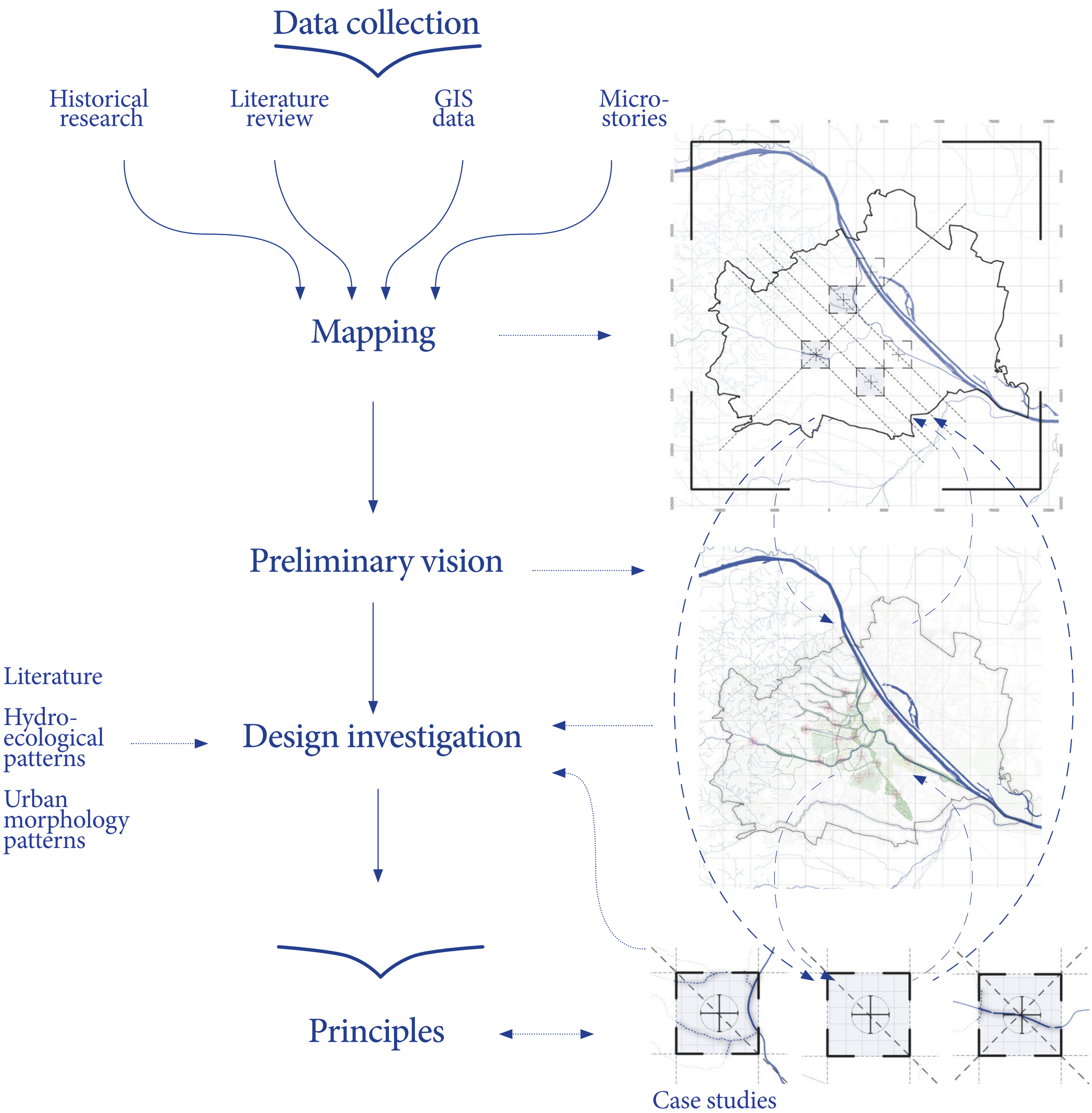
The method captures the thickness of landscapes and their social production through various representation strategies, making the socio-ecological system comprehensible to a non-specialist audience. It constructs a narrative by exploring and visualizing the complexity of the interrelations between ecology and culture (Bernal et al. 2020).

### Research by design

Research by design encompasses three main approaches: research about design and research for design, reflecting design work from a distance without changing it (Jonas 2012: 23) or providing knowledge for design work. In contrast, research through design integrates the act of designing as an essential component of the research (Prominski, 2016: 27). However, it is essential to integrate research for and about design to produce research through design that is both relevant and rigorous (Findeli, 2012).

The design investigation involves a continuous interplay between literature, existing projects, and actual design work based on two to three focus areas. This process utilizes a pattern language as a systematization tool, which is constantly optimized. The research-by-design output consists of systematic and conceptualized patterns presented as conclusions, aligning with Prominski's emphasis on relevance and transferable knowledge.

Combined with the previous literature review and the resulting theoretical/methodological framework, this approach ensures embedding the work in a larger context and validity beyond specific cases (Prominski, 2016: 28). The validation is tested and demonstrated through the multiplication and upscaling of design interventions within a vision.




[Fig. 33]: Method Framework

# 2.3.2 Mapping Framework: Listening & comprehending system interrelations

*Mapping is an extremely tactical enterprise, a practice of relational reasoning that unfolds new realities out of existing constraints, quantities, facts and conditions", if "'tracings' maps, that delineate patterns but reveal nothing new", are to be avoided (Allen 1998; Corner 1999a, 2011).*

## Sources for gathering data

- Historical research: anthropological and archeological studies, historical maps, old photographs, literature
- GIS research: landscape morphology, urban morphology, literature
- Literature: Socio-economic research (distribution of income, migration & education background)
- Fieldwork: Subjective opinions, photographs, drawings

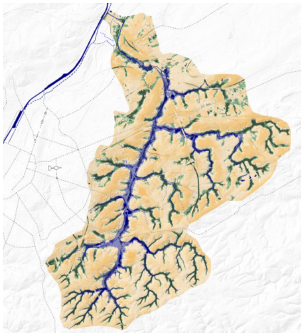


## methods using the data

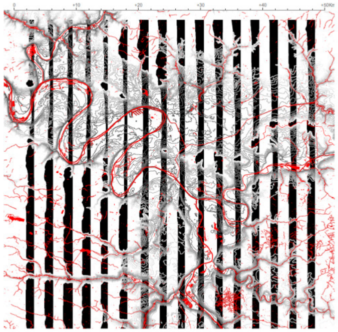
Overlapping, deconstruction, reconstruction, layering, abstraction, conceptualization, comparison

- Territorial mapping (1) (Fig 34-36)
- Urban cell mapping (2) (Fig 37)
- Photographic comparison (3) (Fig 38,39)
- Microstories: not neccessarily refers to small scale, but are counternarratives and descriptions of the original mapping & conventional picture
    - Portraying everyday life by talking to people & taking pictures to understand how and why they are living there (Le Grand Paris I; Secchi & Vigano 2008-2009)
    - Systematically mapping urban situations from a human perspective (numbers, sketches, pictures) (Structure Plan of Antwerp Secchi & Vigano 2003-2007)

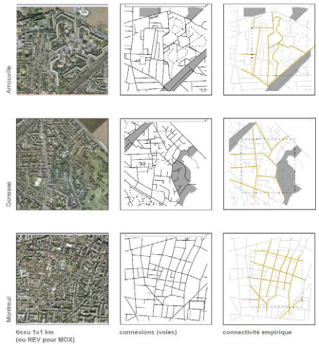
Through the cartographic process, main problems, areas of opportunities, where strategic interventions could have a broader positive impact are identified. The mapping is the base to propose design instruments that are able to translate adaptation measures in space, suggesting context-responsive solutions to the watershed's complex system.



[Fig. 34]: Mapping of water system

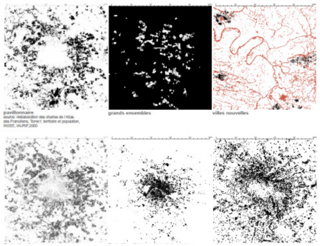


[Fig. 35]: Mapping of hydrotopography



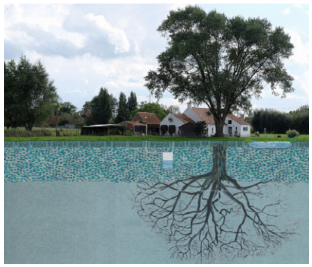


[Fig. 37]: Urban cell comparison

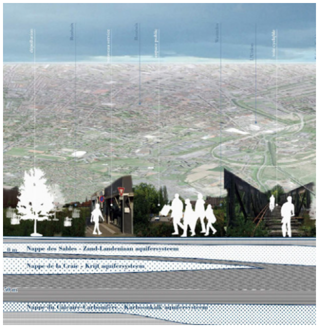




[Fig. 36]: Mapping systemic relations



[Fig. 38]: Section of subsoil condition



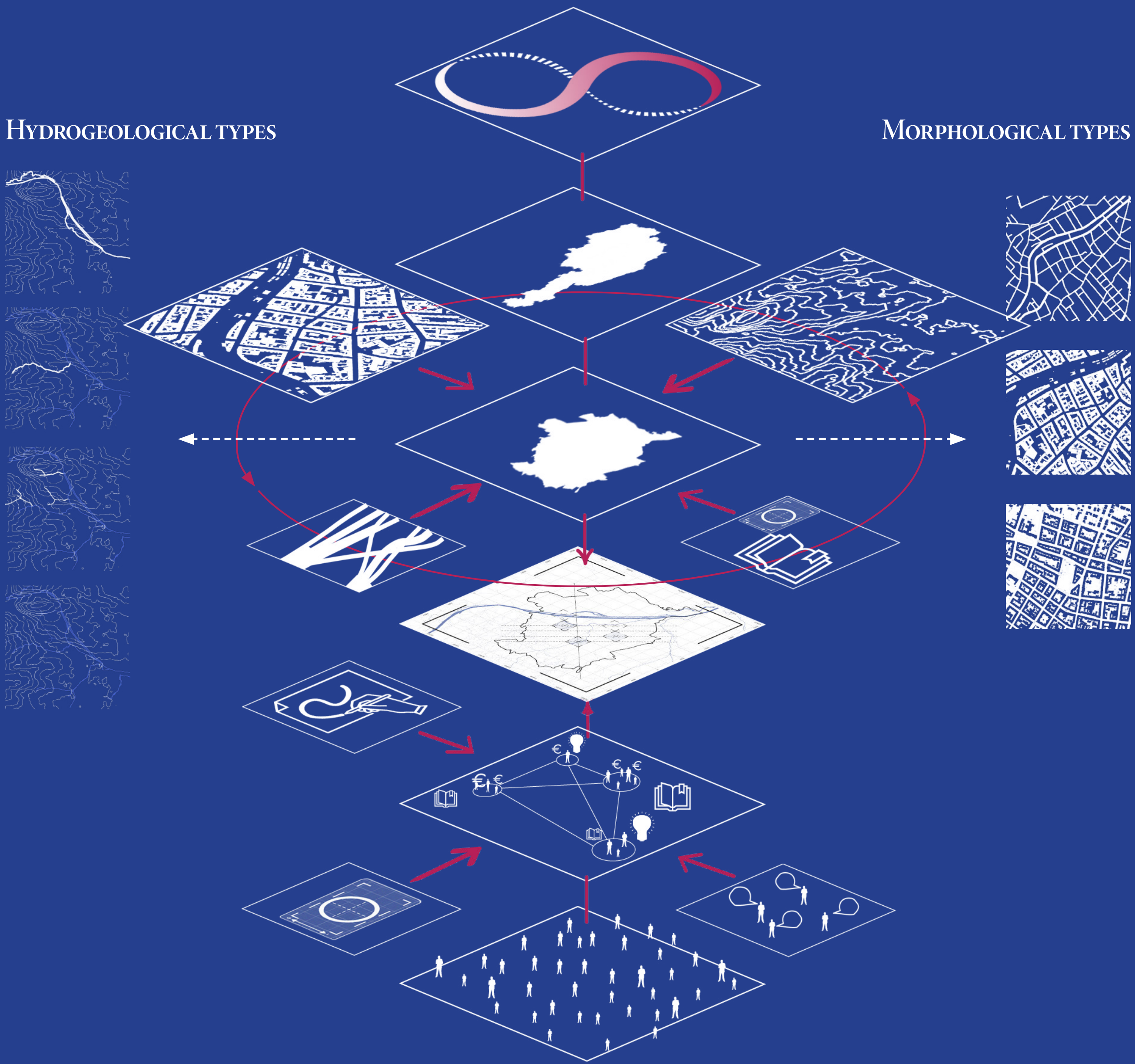
[Fig. 39]: Combining different scales and systems

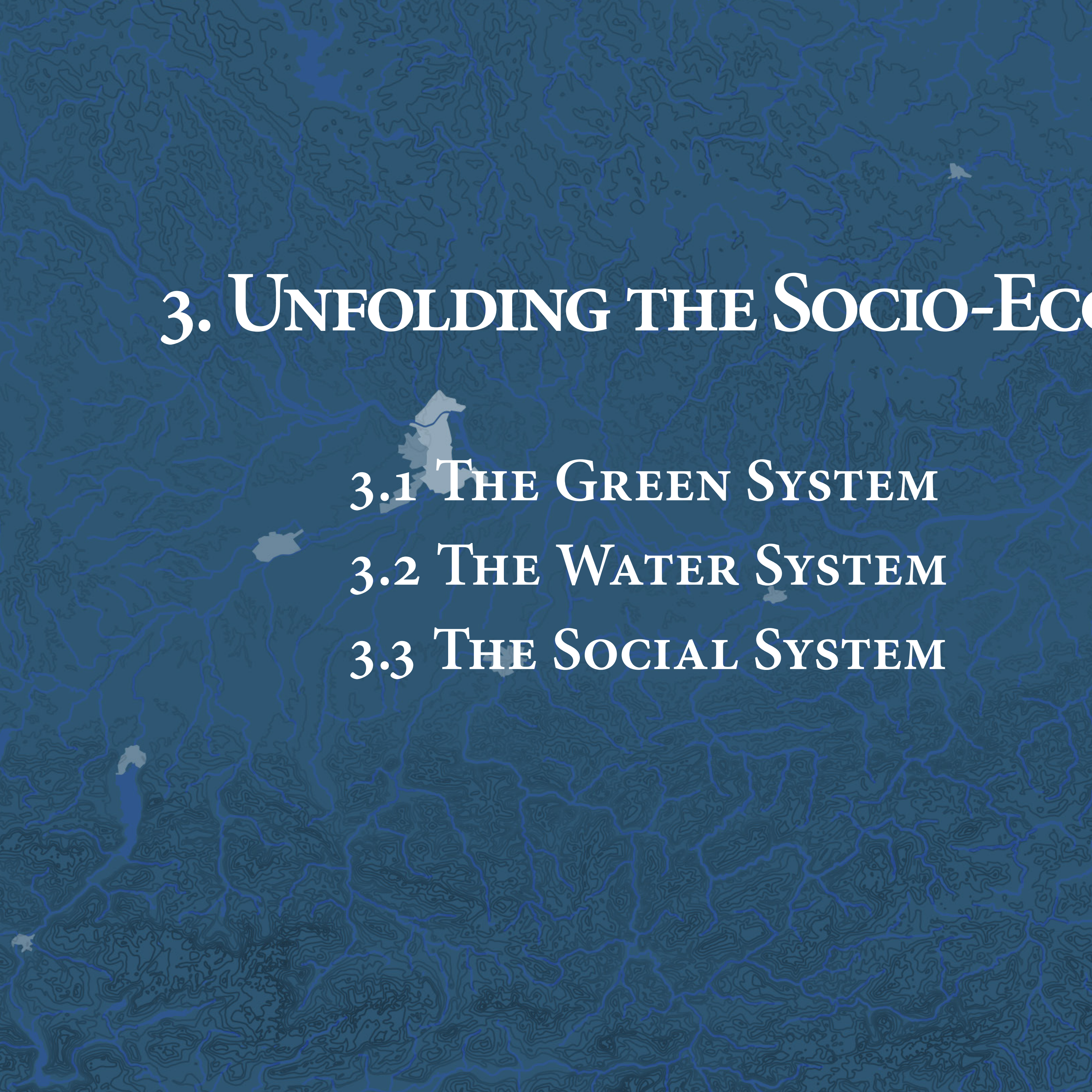
**Notes:**

Fig 34 Source: Woluwe Waterland - fallow + 1010au, 2022

Fig 35-37 Source: Le Grand Paris I - Studio Secchi-Viganò; European Master in Urbanism 2008-2009

Fig 38-39 Source: L'Espace Bleu Eurométropolitain - Studio 8 Paola Viganò, Chiara Cavalieri 2015)


HYDROGEOLOGICAL TYPES
MORPHOLOGICAL TYPES



# 3. Unfolding the Socio-Eco

3.1 The Green System

3.2 The Water System

3.3 The Social System

# ological System of Vienna



*The work of a designer is not isolated from other sciences, rather the design translates and reformulates initial concepts, by doing so "it intersecs with others and gives rise to an original product that, in turn, then crosses different fields of knowlege" (Vigano, 2016:25).*

In this chapter, landscape morphology and urban morphology of Vienna through the lens of environmental justice are analysed.

The analysis framework attempts to listen to and unfold the socio-ecological system, using the green & water system, representing the ecosystem, as the entry and starting point. This allows to explore spatial and social dependencies, illuminating their interactions with various urban systems and societal vulnerabilities.

Thereby, possible pathways for a climate-resilient trajectory are drawn.

# 3. Unfolding the Socio-Ecological System of Vienna

## The Green-Blue System interwoven in the Social System

In the process of unfolding Vienna's socio-ecological system, the aim is to establish a profound connection within all its layers, encompassing aspects such as landscape morphology and urban morphology, and relate them to their cultural contexts.

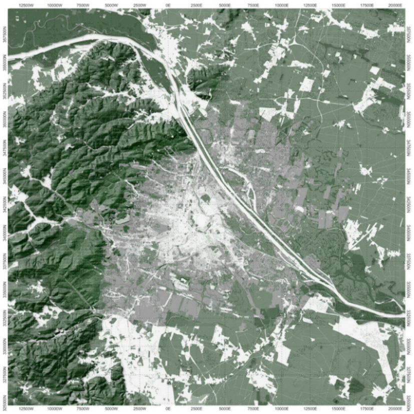
This sensitive ethnographic approach uncovers diverse and at times contradictory practices, objects, symbols, and discourses in daily life, akin to an 'ecology of methods' as proposed by Hamilton and Taylor (2017). It involves engaging with the landscape to discover its identity and 'Nature' and develop methodologies for Urbanists, extending the design agency to include non-human elements.

This method emphasizes a holistic and inclusive approach to ethnography, recognizing the multifaceted nature of cultural practices and the involvement of non-human elements.

Ultimately, it unveils correlations between the development and the character of the green-blue system and the city's social system, manifesting at various scales.

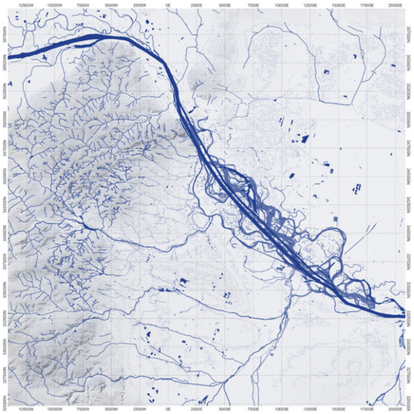



[Fig. 40]: Different layers of the socio-ecological system under investigation



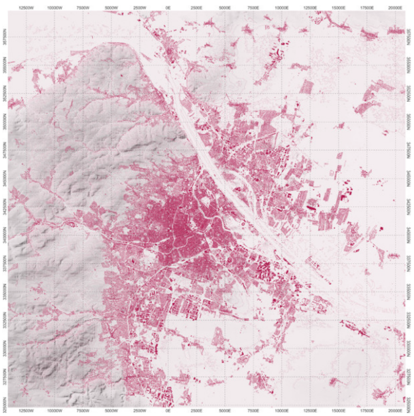
## The Green System

Analyzing the green system involves a comprehensive study of Vienna's ecosystem in conjunction with the urban system. This exploration delves into understanding its role, examining spatial patterns of disparities, and assessing the distribution of ecosystem services throughout Vienna. The study encompasses an examination of the green system's cultural value. Beyond human perspectives, it recognizes the role of flora and fauna, emphasizing their reciprocal influence. Listening to the green system demonstrates the transformative impact of the green and urban systems, showcasing their interconnectedness.



## The Blue System

Examining the blue system entails delving into Vienna's landscape, the hydro-morphological system, its processes, and the interplay with the socio-ecological system. This encompasses studying the evolution of water-related infrastructure and its implications for the present water system.
The process involves reimagining the original water system and its influence on the city's systems, unveiling enduring patterns with potential implications for climate resilience and the resurgence of historical cultural and identity values.



## The Social System

The social system is frequently presented in conjunction with the green-blue system to highlight interrelations. This encompasses all aspects of human-made entities, particularly the urban and cultural landscape, including its (infrastructural) systems. Social vulnerabilities, characterized by low income, are linked to environmental conditions and public accessibility, clarifying areas that require attention to achieve greater environmental justice. Cultural and societal values, local knowledge, and community demands are recognized and contextualized to identify and promote social benefits.

[Fig. 41-43]: The green, the blue and the social system and their development as systems of investigation



# 3.1 The Green system of Vienna: A concentrated and Dispersed provision of Services

This chapter analyzes the causes of overheating and fragmentation in Vienna by unfolding the green system and showing its role in the city. The investigation explores the values that the ecosystem provides and assesses Vienna's green spaces, examining its landscape, composed of concentrated and dispersed green spaces. Further, qualities like biodiversity of public green spaces and social benefits, are investigated. Detailed area assessments and photographs reveal qualities, and resident opinions provide valuable insights. The connection between urban spaces and green space accessibility and distribution is explored. Following, this is set in context with population density and building density.

The investigation, covering aspects such as green spaces, surface sealing, district characteristics, and green space accessibility, seeks to provide a holistic overview across relevant layers and scales (Fig. 44-47). This structured analysis aims to unveil the complex dynamics shaping Vienna's urban environment, giving a voice to human and non-human actors and investigating space for action for improved resilient green spaces.

**Notes:**

[Fig. 44]: Public accessible parks and green areas within Vienna
*Datasource: Stadt Wien 2023, Geofabrik 2023*

[Fig. 45]: Distribution of trees in Vienna
*Datasource: Stadt Wien 2023, EEA 2018*

[Fig. 46]: Different types of greenspaces and their ecosystem values
*Datasource: Stadt Wien 2023, Geofabrik 2023*

[Fig. 47]: Soil types in Vienna
*Datasource: Stadt Wien 2023, Geofabrik 2023*

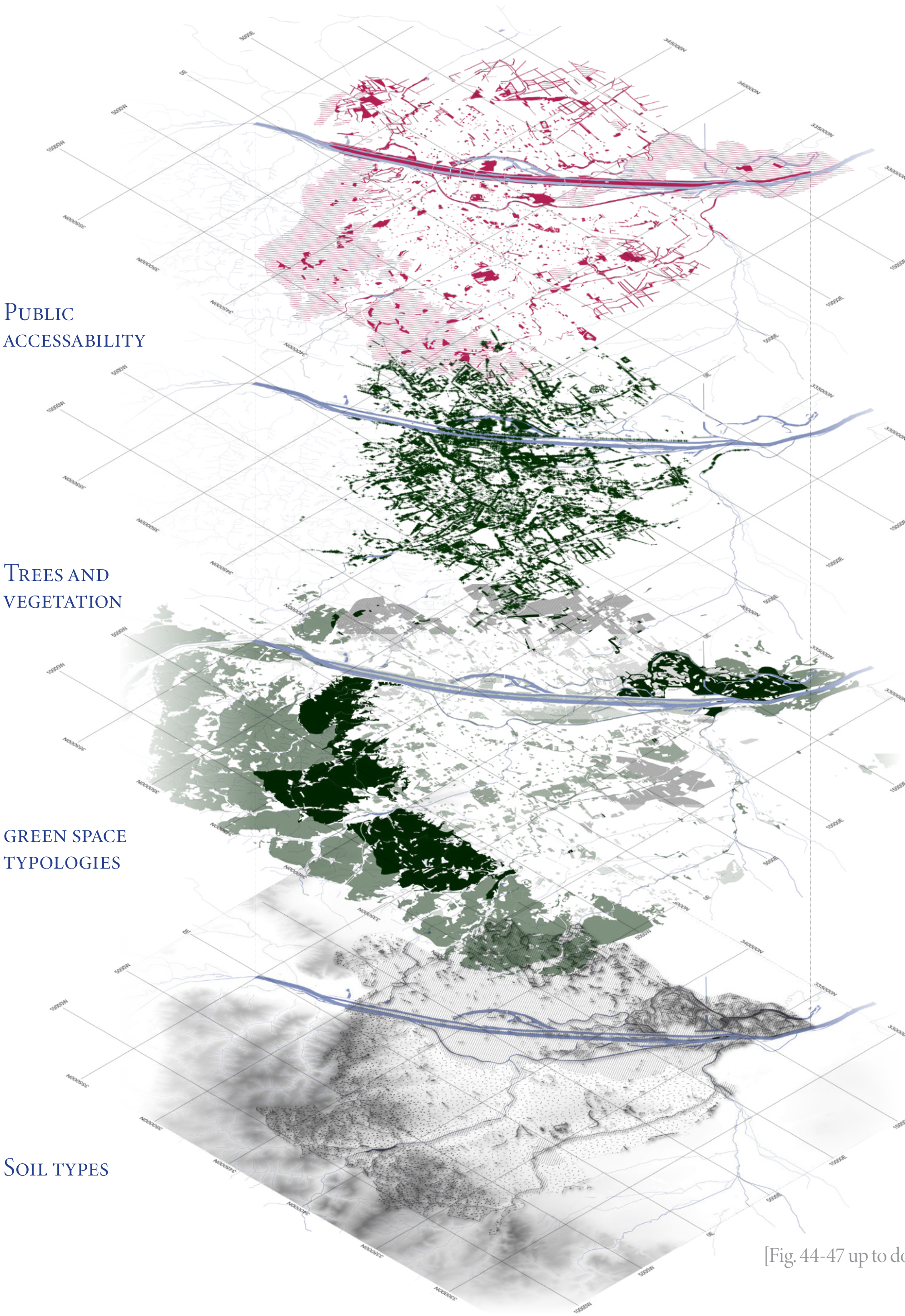
**Legend**

Public accessible
- Natural areas (forests)
- Urban green spaces (Parks)

Tree distribution
- Tree vegetation

Ecosystem typologies
- Forest
- Urban (green) parks
- Meadows/ Gardens
- Agricultural used land
- Monocultural sport facilities

Soil typologies
- Terraces
- Floodplain area below
- Floodplain area above
- Gravel bank
- Stream bed



[Fig. 44-47 up to down]

# Urban Ecosystems and it's link to ecosystem services

## Urban ecosystems

Ecosystems, here widely named green systems, can be described as the interplay between various species and their immediate, non-biological surroundings, working harmoniously to sustain life (Moll and Petit, 1994).

However, defining the precise boundaries of ecosystems can be complex. In the context of urban areas, it is possible to consider the city as a complete ecosystem or recognizing it as a composite of distinct individual ecosystems, such as parks and lakes (Rebele, 1994).

To maintain clarity, the term "urban ecosystems" is used to encompass all natural green and blue spaces within the city, encompassing features like street trees and ponds within this classification. In reality, street trees, due to their limited size, are not regarded as complete ecosystems but rather as components of a larger ecological system.

Based on Bolund & Hunhammar (1999), seven distinct urban ecosystems, referred to as "natural," despite the extensive human manipulation and management in urban areas, are identified. These categorized ecosystems encompass street trees, lawns/parks, urban forests, cultivated land, wetlands, standing waters, and streams.

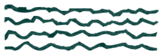
It's worth noting that other areas within the city, such as dumps and neglected backyards, can also support significant populations of plants and animals. However, most urban ecosystems or elements can generally fit into one of the categories mentioned above.

This classification is broad and may need to be adjusted based on site-specific conditions (Bolund and Hunhammar 1999).

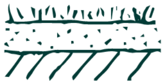
**Wetlands:**
These encompass diverse types of marshes and swamps.

**Urban forests:**
These areas are less managed and feature a denser tree cover compared to parks.

**Lakes:**
This category includes open water areas.



**Streams:**
Refers to flowing water bodies.



**Cultivated land & gardens:**
These spaces are used for growing a variety of food items.

**Lawns/parks:**
These are well-maintained green areas with a mix of grass, mature trees, and various plants, including places like playgrounds..

**Street trees:**
These are solitary trees typically surrounded by pavement (Bolund and Hunhammar 1999).

[Fig. 48]: The green, the blue and the social system and their development as systems of investigation

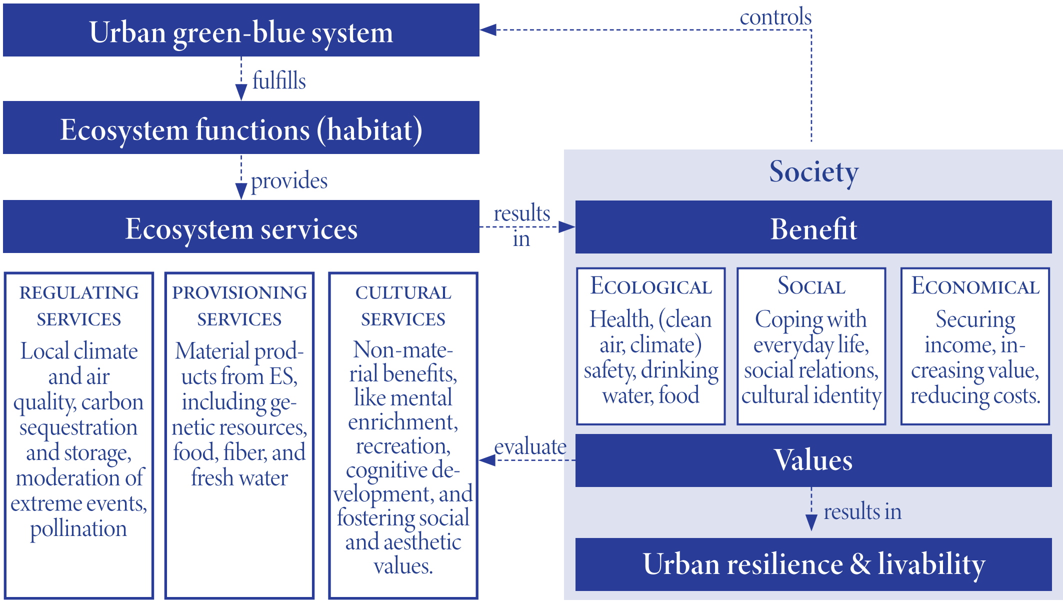
## ECOSYSTEM SERVICES

Ecosystem services, defined as "the benefits derived by human populations from ecosystem functions" (Costanza et al., 1997), encompass 17 major categories. "The Economics of Ecosystem Services and Biodiversity" (TEEB 2010) groups them into four primary categories: provisioning, regulating, habitat, and cultural and amenity services (TEEB 2010). Notably, some of these services are not directly consumed by humans but are vital for sustaining ecosystems, including pollination and nutrient cycling.

While the classification of ecosystem services can be complex, it's important to note that their significance varies considerably based on the unique environmental and socio-economic characteristics of each location. Additionally, these services may have varying spatial coverage (Bolund and Hunhammar 1999, Gómez-Baggethun et al. 2013).

This paper primarily addresses urban areas, with a specific focus on direct, locally generated services relevant to Vienna.

Urban green-blue systems and their ecosystems are, in addition to climatic and ecological improvement, of particular importance for inhabitants in terms of social aspects and contributing significantly to quality of life in the city (Kabisch and Haase, 2014).




[Fig.49]: Correlation of urban green-blue system and societal benefits & urban resilience
*Source: Ring et al. 2021*

## Vital ecosystem services

From the 17 service groups identified by Costanza et al. (1997), six are deemed particularly vital in urban settings: air filtering (gas regulation), micro-climate regulation, noise reduction (disturbance regulation), rainwater drainage (water regulation), sewage treatment (waste treatment), and recreational/cultural values. Although services like food production and erosion control could be considered, they are not of significant relevance for Vienna. The paper delves into various aspects of each of these addressed services.

Supporting or habitat services are essential for generating all other ecosystem services. They include biomass production, nutrient cycling, water cycling, habitat provisioning for species, and the maintenance of genetic diversity and evolutionary processes

***How and to which extent are ecosystem services provided in Vienna and where are potentials?***

| | Street tree | Lawns/ Parks | Urban forest | Cultivated land | Wetland | Stream/ Lake |
|---|---|---|---|---|---|---|
| **Micro-climate regul.** | X | X | X | X | X | X |
| **Rainwater drainage** | | X | X | X | X | X |
| **Water purification** | | | | | X | |
| **Recreational/cultural** | X | X | X | X | X | X |
| **Noise reduction** | X | X | X | X | X | |
| **Air purification** | X | X | X | X | X | |

[Tab.1]: Urban ecosystems generating local and direct services (Bolund and Hunhammar 1999)

Adopting a nature-based approach, natural streams and water bodies exist in harmonious coexistence with other urban green ecosystems. This synergy fosters robust connections that significantly enhance habitat support and the delivery of vital ecosystem services. Furthermore, this approach addresses the essential aspects of water distribution and storage.

1. MICRO-CLIMATE REGULATION
Trees and other urban vegetation provide shade, create humidity and block wind (photosynthesis, shading, and evapotranspiration).

2. RAINWATER DRAINAGE
Soil and vegetation percolate water during heavy/ prolonged precipitation events (percolation, regulation and storing of runoff and river discharge)

3. WATER PURIFICATION
Effluent filtering and nutrient fixation by urban wetlands (removal or breakdown of xenic nutrients)

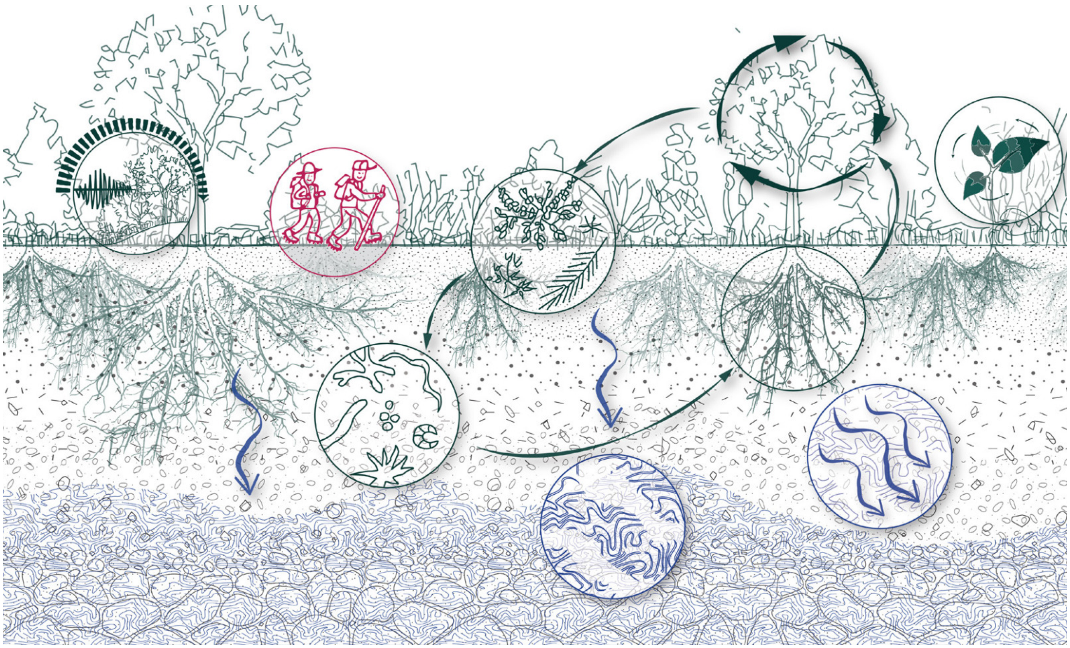
4. RECREATIONAL/CULTURAL VALUES
Relaxation, cognitive growth, and knowledge retention via participation, reification and external sources (experiencing ecosystem services).

5. HABITAT FOR BIODIVERSITY
Urban green spaces provide habitat for birds and other animals (habitat provision)

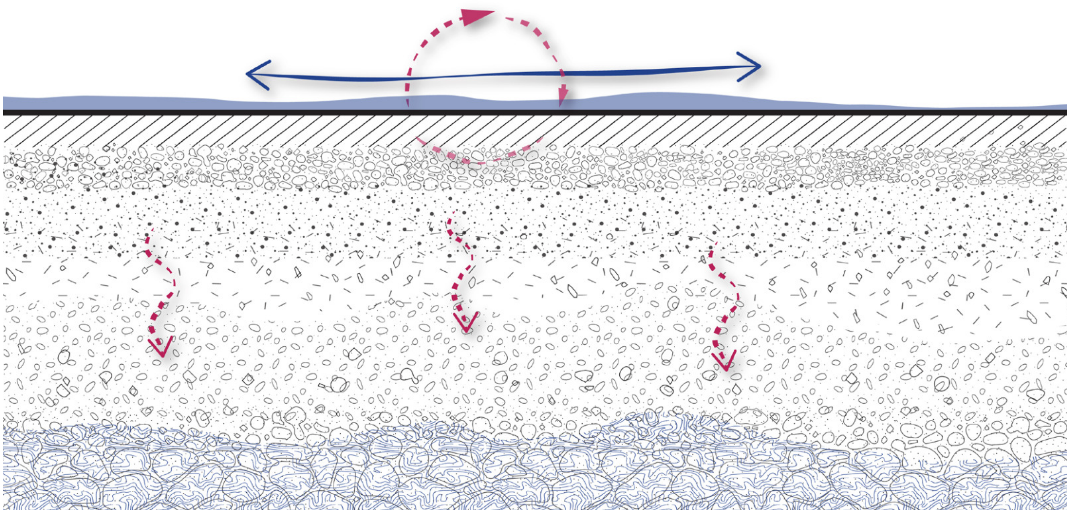
6. NOISE REDUCTION
Absorption of sound waves by vegetation barriers and water.

7. AIR PURIFICATION
Absorption of pollutants by urban vegetation in leaves, stems and roots (dry deposition of gases and particulate matter.

[Fig.50]: Ecosystem services and their functions (Gómez-Baggethun et al. 2013)



[Fig.51]: Functioning ecosystem generating among others biomass production, nutrient cycling, water cycling, and habitat provisioning for species.



[Fig.52]: Impact of sealing on the soil results in diminishing presence of water, plants, and essential microorganisms providing no ecosystem services,

## 3.1.1 Vienna's green spaces and their services

### Vienna's landscapes

Vienna boasts a vast and diverse ecological structure. This green structure evolved and consolidated over millennia through natural circumstances and cultural influences. Shaped by the interplay of urban and cultural landscapes, this natural landscape has resulted in different manifestations.

Vienna's landscape is composed of five distinctive landscapes, offering a rich natural foundation with specific characteristics in flora and fauna. These areas display remarkable diversity and contribute to the diversity of 'Viennese landscapes' with their unique features.

They vary in terms of hydrogeology, geography, and climate, creating diverse landscape profiles while also presenting areas of both conflict and potential. These landscapes are Bisamberg, Marchfeld, Wienerwald, Donauraum, and the terrace landscapes in the south of Vienna.



[Fig.53]: Viennas landscape is distinguished by five different landscape typologies
*Source: Fachkonzept 2025 Grün- und Freiraum, MA18 Wien 2015.*

## Bisamberg

Bisamberg is a region defined by woodlands, valuable ecosystems, and agricultural activities, including vineyards. It holds a unique value as a recreational space for Vienna's 21st district and nearby communities in Lower Austria. Additionally, the Bisamberg periphery is becoming increasingly appealing for residential development.

## Marchfeld

The fertile Marchfeld region plays a crucial role in providing Vienna with vegetables and grains. Additionally, it offers room for urban and green space expansion. In light of the evolving regional development dynamics, it's important to continue developing the unique landscape features of this region in partnership with neighboring towns.

## Wienerwald

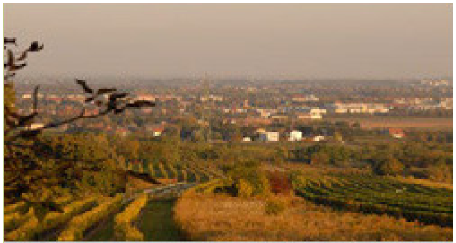
The mixed deciduous forests found in Vienna's northwestern and western areas, collectively known as Wienerwald, are a vital ecological and urban climate asset, often referred to as Vienna's "green lung." Notably, this landscape is defined by the alternating presence of forests and open spaces, some of which are used for farming, with vineyards being a special characteristic in Vienna's territory.

## Donauraum

The Old and New Danube rivers, together with Lobau within the National Park Donau-Auen, are unique habitats and leisure destinations. It is of crucial importance to preserve these recreational spaces in the years to come and continually improve their facilities.

## Terrassenlandschaften im Süden von Wien

The extensive plain in the southern part of the Vienna Basin is intersected by a multitude of Vienna Woods streams that flow from the west to the east. It is delimited in the north by Wienerberg, Laaer Berg, and Goldberg. This landscape is also characterized by recreational zones (MA18 Wien, 2015).



## Viennas ecosystem structure

Vienna stands as one of the most verdant cities, with 50% of its total area covered by green spaces. The city owes this notable value primarily to its expansive centralized green areas and vital biotopes, such as the Wienerwald, the Prater, and the Donauinsel.

The extensive green space structure along the Danube and in the west of Vienna along the increasing topography is supplemented by small-scale green structures in the urban landscape. However, these are relatively dispersed, as many inner-city areas are extensively sealed and no distinct green corridors are recognisable. This results in a fragmentation of the green space.

*To enhance biodiversity and the urban ecosystem, the connection of green spaces is of particular importance, as well as the creation of ecosystem corridors.*

Legend

Forest

Urban (green) parks

Meadows/ Gardens

Agricultural used land

Monocultural sport facilities

Public accessible green spaces

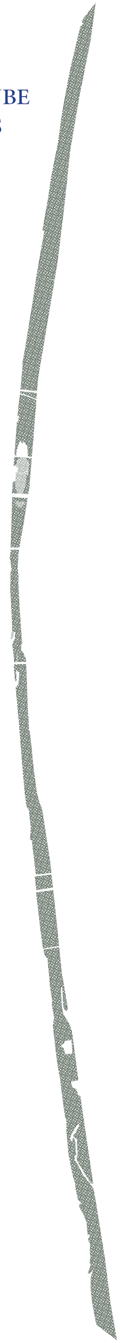
Water bodies

Tree cown size

Tree cown size

Tree cown size

1. Danube Islands



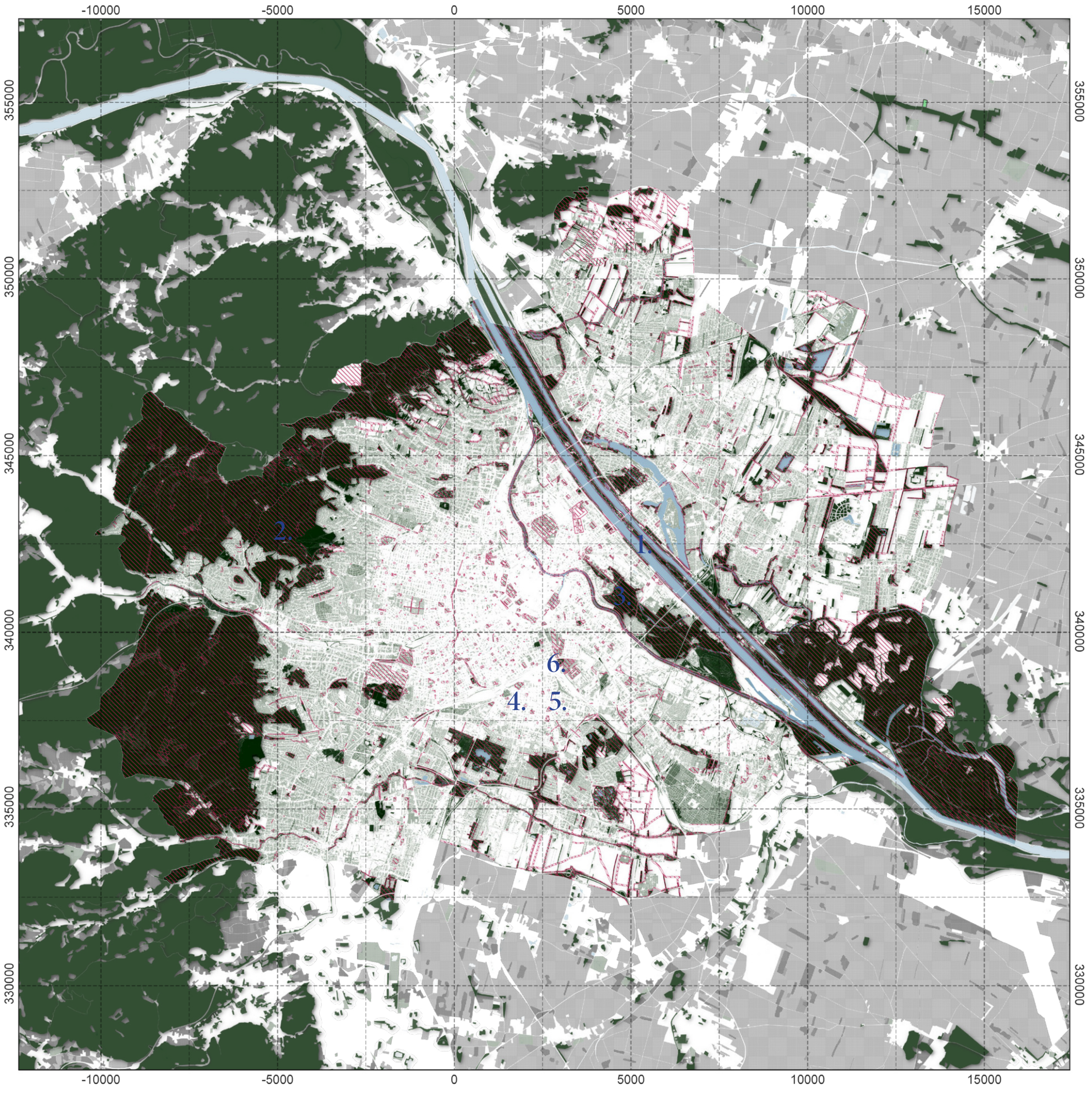
2. Vienna Woods

3. Prater

4. Residential street - Favoriten

5. Keplerpark

6. Sonnwendplatz




[Fig.54]: Green space types and their usage with public accessability
*Datasource: Stadt Wien 2023*

## Concentrated Green Spaces

Vienna boasts abundant green spaces, primarily found in the Wienerwald, Prater, and Danube Island. These areas feature diverse actors, including flora, fauna, and humans. The ecosystems encompass various surfaces and soils, providing essential ecosystem services. Additionally, they hold cultural and recreational value for humans, though they face high usage pressure.

### Vienna woods

The Vienna Woods, spanning about 135,000 hectares in the west of Vienna, is a vital biotope with high biodiversity. Recognized by UNESCO as a Biosphere Reserve, this woodland has to provide coexistence of nature and human activities.

Diverse habitats within the forest contribute to its conservation value, with distinct climate types, soil formations, and a wide range of landscapes, it hosts over 5,000 animal and 2,000 plant species. From open fields and orchards to extensive beech and oak forests, the Vienna Woods showcase diverse ecosystems.

Cherished by Viennese residents for recreation, the woods feature a network of well-maintained hiking and biking trails, attracting outdoor enthusiasts (Stadt Wien 2017).

### Actors

[Fig.55]: Collage of Ecosystem Wienerwald

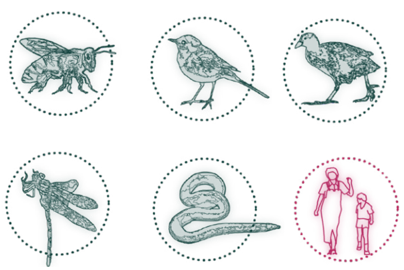
## Danube island

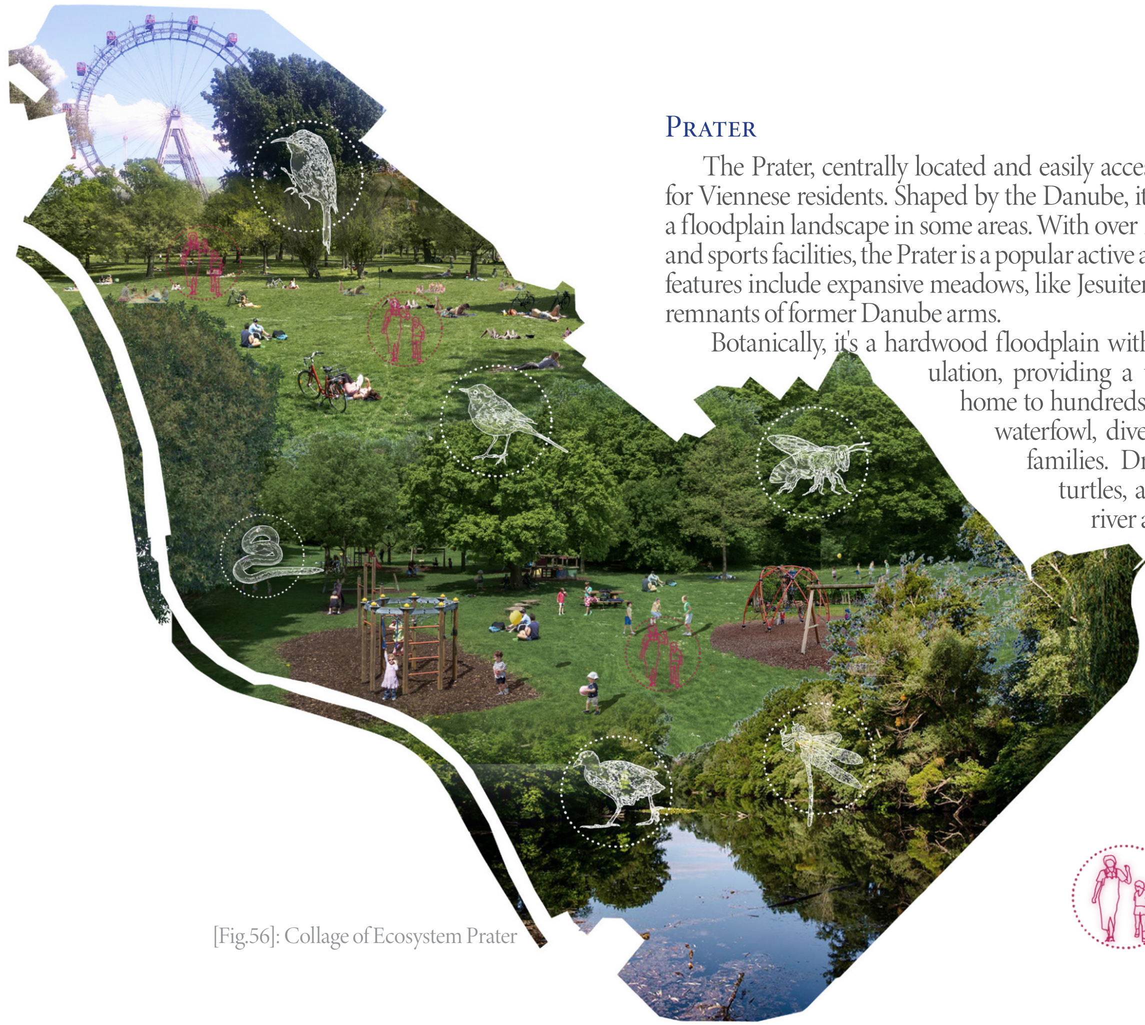
The 21-kilometer-long Danube Island is a popular destination for diverse recreational activities, featuring green spaces, paths, and artificial beaches. Its design preserves old Danube branches and creates biotopes, fostering a diverse habitat for flora and fauna.

Rich dry meadows, secluded ponds, and natural shore areas provide suitable environments for many insects, rare bird and frog species. While offering ecological niches in quieter sections, the island acts hydrologically as a filter in the percolation connection between the main river and the New Danube.

The island's immense popularity leads increasingly to overcrowding in the summer, compromising space for the ecosystem (Stadt Wien 2017).

### Actors





[Fig.56]: Collage of Ecosystem Prater

## Prater

The Prater, centrally located and easily accessible, is a valued green oasis for Viennese residents. Shaped by the Danube, it retains the characteristics of a floodplain landscape in some areas. With over 127,000 square meters of play and sports facilities, the Prater is a popular active and recreational area. Notable features include expansive meadows, like Jesuitenwiese, and water bodies like remnants of former Danube arms.

Botanically, it's a hardwood floodplain with a remarkable old tree population, providing a unique habitat. The Park is home to hundreds of animal species, attracting waterfowl, diverse bird species, and beaver families. Dragonflies, fish, amphibians, turtles, and frogs thrive in its former river arms (Stadt Wien 2017).

### Actors

[Fig.57]: Collage of Ecosystem Danube Island

## Dispersed green spaces

Vienna offers numerous squares and parks of high quality for its residents. However, despite efforts to enhance greenery, such as the installation of new green islands on many streets, these measures often seem like a drop in the ocean. This is because a considerable percentage of both neighborhood parks and street spaces remains sealed, primarily dedicated to motorized individual traffic. It often feels as nature and the ecosystem are given just very limited and controlled space.

During field trips in December 2022 and August 2023, images and perspectives from residents and space users were gathered, collectively forming an subjective portrayal of public spaces.

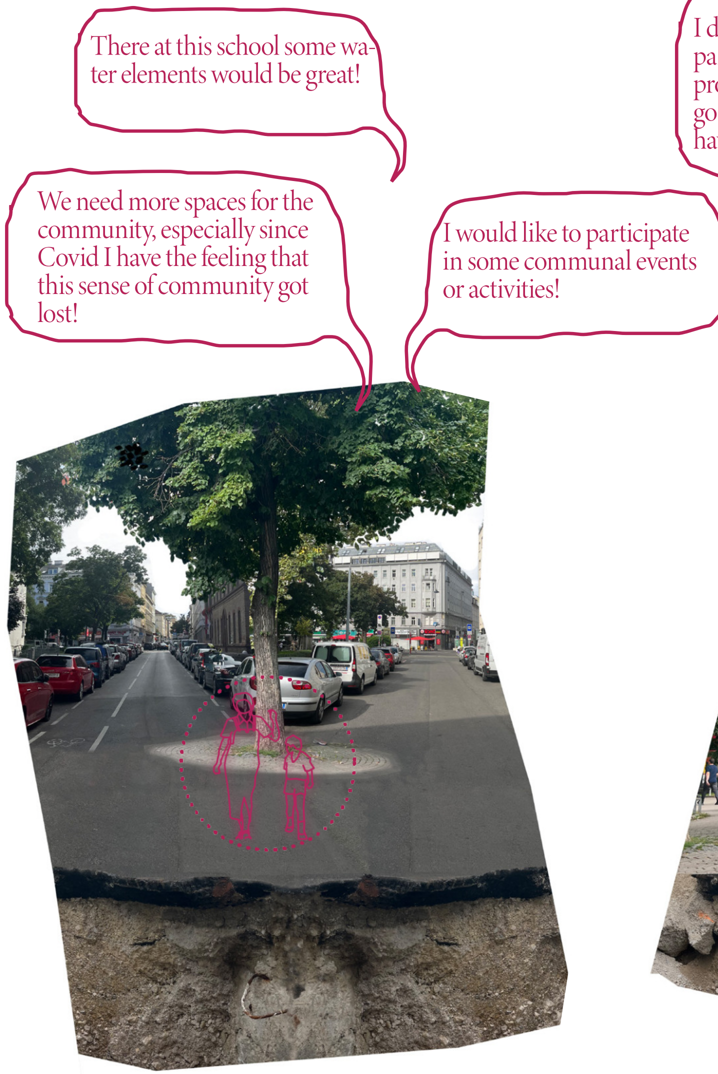
***The findings reveal disparities not only in the distribution of green spaces but more significantly in how they are perceived and the awareness of their accessibility.***



Individuals residing in areas with fewer green spaces tended to perceive and miss them less. Moreover, they showed less awareness of the positive impact green spaces can have on climate and overall quality of life. The absence of green spaces seemed often less recognized as a concern in these areas.

To address this issues, there needs to be a shift in the approach and paradigm of planning and designing public spaces. It's essential to prioritize the ecosystem and the integration of green elements in public spaces as equally important aspects of urban planning.

### Residential street - Favoriten




### Keplerpark

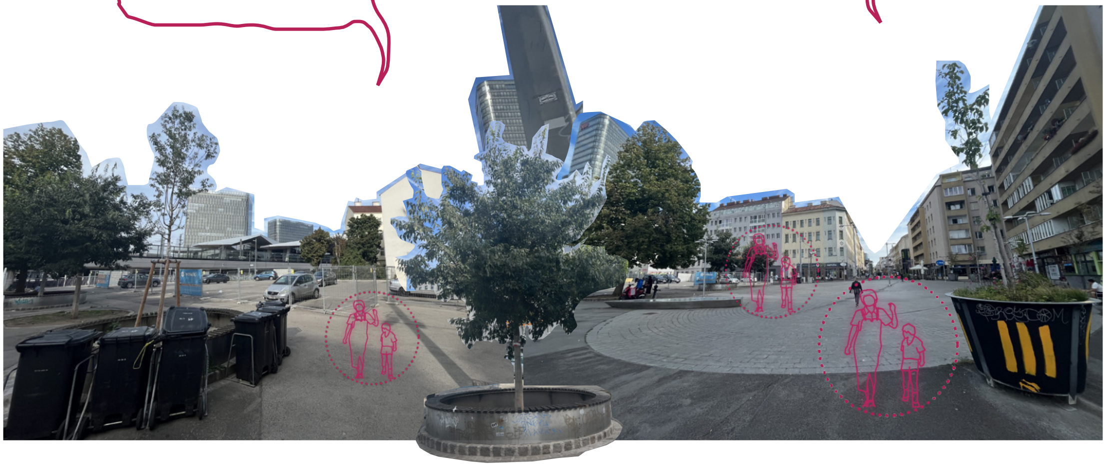
## Sonnwendplatz

This tree has many hazelnuts, I collect them for cooking!

I am from Syria, it is great here!

The only problem we have here are the foreigners, the heat is not the problem, some restaurants & bars already put some pots out!

Everything is fine here, I don't miss anything. I just openend my kiosk here.



### Actors (exemplary for all shown urban spaces)

These are statements collected in conversations with residents and users of the spaces in Favoriten and Hernals, added with some own perceptions.

[Fig.58-60]:Microstories about public space Hernals-Favoriten

# 3.1.2 Variations in Urban Green Space Distribution and Accessibility

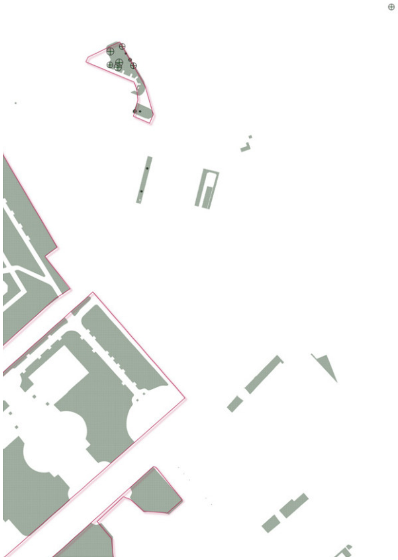
## Differences in distribution of green space

This study displays correlations among different urban districts within the city based on their urban fabric, the typology and provision of green spaces (therefore extent of surface sealing) and their accessibility. This reveals substantial disparities in the distribution and accessibility of green spaces.

A notable observation is that a significant portion of these green areas is privately owned and thus inaccessible to the majority of residents. Furthermore, it becomes apparent that certain building typology neighbourhoods traditionally associated with higher costs, such as townhouses and single-household dwellings, tend to provide better access to green and blue infrastructure.

In districts characterized by Gründerzeit blocks, historical city cores, and post-war urban development, the presence of green spaces and their associated ecological value is notably limited or non-existent.

## Historical city core



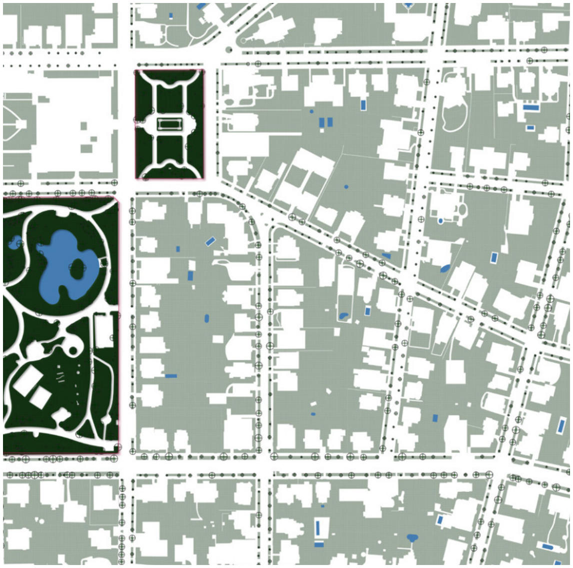
## Urban block (Gründerzeit)

[Fig.61]: Green stamp in urban fabric & public accessibility
*Datasource: Stadt Wien 2023*

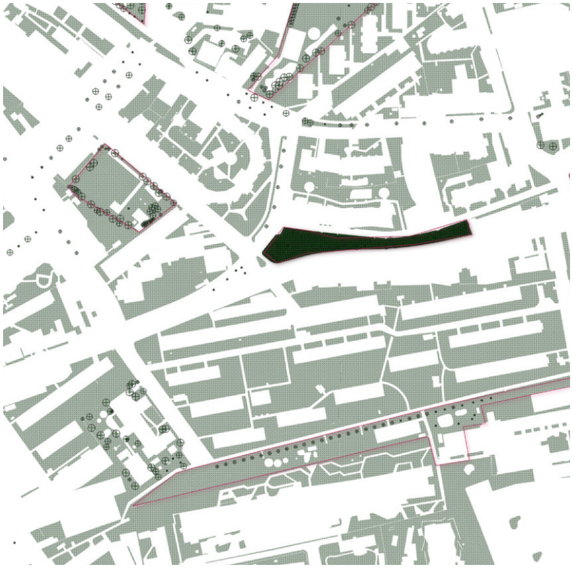
**Legend**

- Forest
- Urban (green) parks
- Meadows/ Gardens
- Agricultural used land
- Monocultural sport facilities
- Public accessible green spaces
- Water bodies
- Tree cown size
- Tree cown size
- Tree cown size

### Townhouses & multi-household dwelling

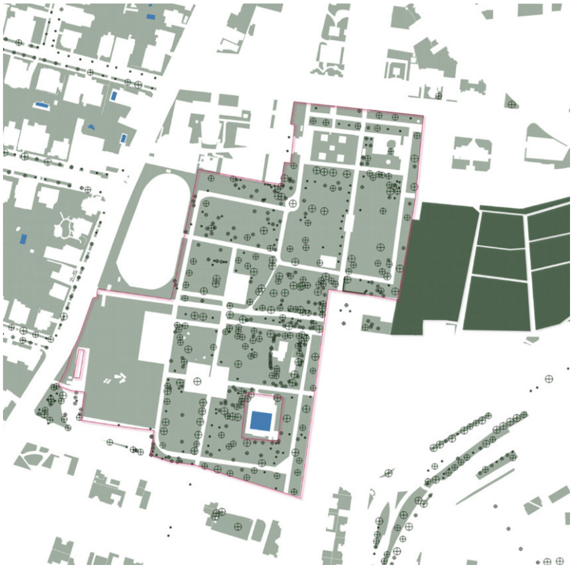


### Post-war modern urban development



### Single-household dwelling

### Public & special typologies



# 3.1.3 Urban fabric types in a high density Environment

## Connection of heat, high density and green space

A decrease in green spaces corresponds to an increase in surface sealing, which is directly linked to higher building densities (GSI).

During hot summer days, asphalt and concrete absorb and emit heat, and the lack of green areas and evapotranspiration, along with minimal wind due to obstructive buildings, hinder cooling. This leads to high land surface temperatures (LST), as depicted on the map. The consequence is Urban heat islands (UHI), causing reduced livability and posing health hazards to both humans and the remaining vegetation, particularly on days of extreme heat.

As observed on the map, urban areas with high building density, such as historical city cores, Gründerzeit blocks, and certain post-war development areas, are particularly affected by these conditions.

Historical city core (GSI: 0,75-0,9)

Gründerzeit block (GSI: 0,6-0,75 )

Post-war modern urban development (GSI: 0,45-0,6)

Public & special typologies (GSI: varies)

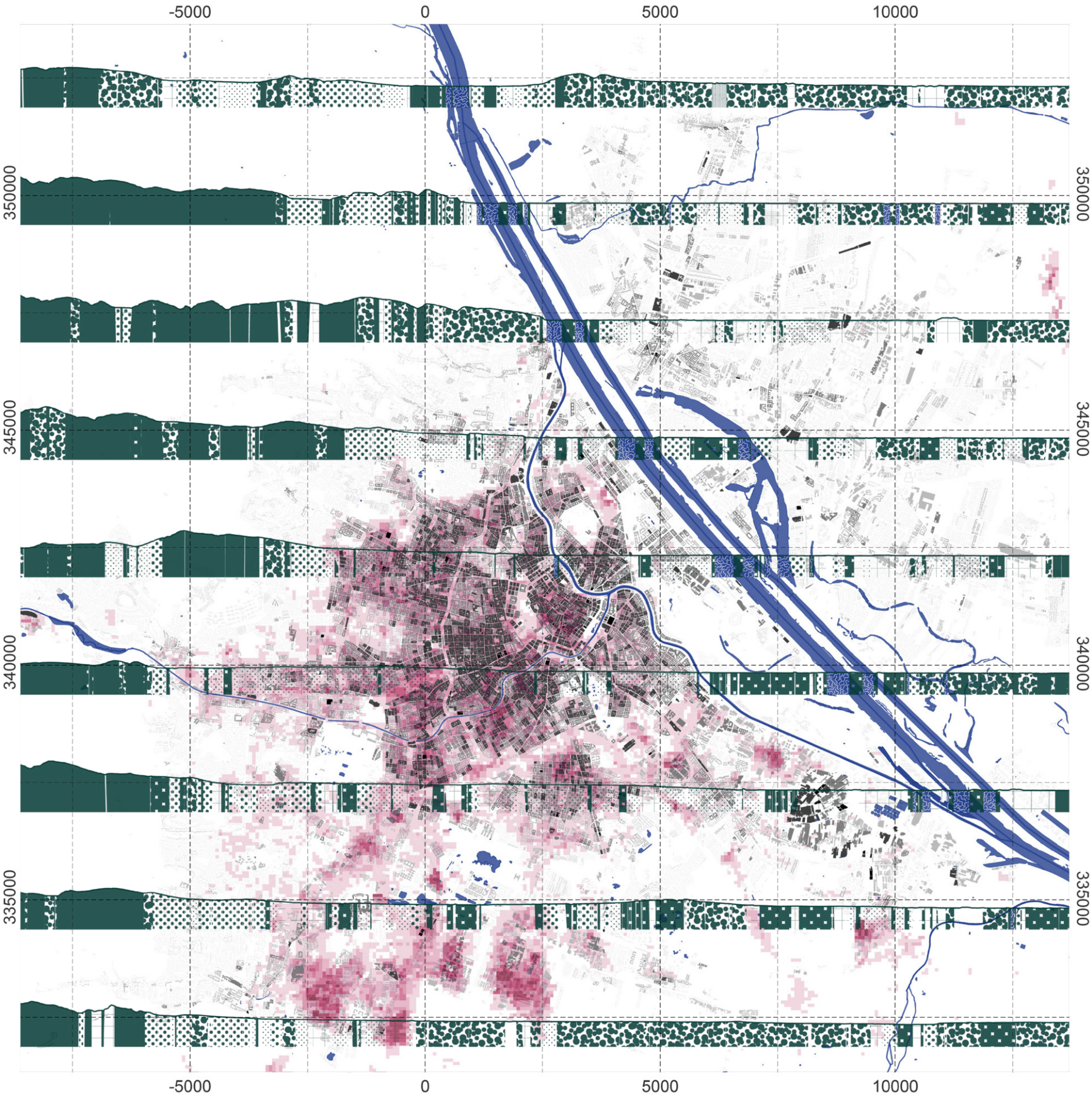
Townhouses and multi-household dwelling (GSI: 0,3-0,45)

Single-household dwelling (GSI: 0,3)

[Fig.62-68]: Urban fabric types and their density
*Source: Simperler et al. 2018*

**Legend**

| Green Space Typologies | Land Surface Temperature (LST) | Ground Space Index (GSI) |
|---|---|---|
| Natural areas (forest) | 53-48 °C | 0,75-0,9 |
| Agricultural used land | 48-47 °C | 0,6-0,75 |
| Urban (green) parks | 47-46 °C | 0,45-0,6 |
| Low density build areas | 46-45 °C | 0,3-0,45 |
| High density build areas | 45-44 °C | 0,3 and lower |
| Industrial areas | 44-42 °C | |




[Fig.69]: LST, GSI and green space typologies
*Datasource: EEA 2018, NASA 2023, Stadt Wien 2023*

## Focus on Urban Fabric districts: Characteristics of density, green Space, and ownership

Urban fabric neighborhoods like Urban Blocks and Post-war modern developments are characterized by high population densities, creating a substantial demand for green spaces due to intense utilization.

However, as noted in the prior research, in particular these areas have a low availability of green space and high proportions of sealed surfaces, not to mention the scarcity of public accessible green spaces. This physically and mentally distances significant portion of Vienna's residents from the Ecosystem, particularly those who are already marginalized.

The often private courtyards of the Gründerzeit blocks offer potential for communal use and greening, however, they alone cannot provide sufficent ecosystem services for these neighbourhoods. The transformation requires intensive redesign of public and street spaces, including de-sealing efforts.

Post-war development offers potential for the redevelopment and utilization of open spaces due to their limited soil sealing. These spaces are often marginalized and underutilized.

Public and Special Typologies possess significant potential for redesign and greening to enhance climate resilience, given their existing public use and public ownership.

The many publicly owned residential buildings in areas like Gründerzeit and Post-war development districts also hold promise for simplified climate-resilient redesign and enhancement, due to their ownership status.




[Fig.70]: Pressure of use on public space
*Source: Stadt Wien 2020s*

## Urban block (Gründerzeit) disticts

Surface layout: - low distribution of green space
- high ratio of surface sealing

Urban fabric: - high building and population density

Program: - mixed use, especially in ground floor
- mainly residential, social housing present

Ownership: - high diversity of owners
- social housing publicity owned

Area of action: - Courtyards, public spaces (streets, squares)

## Post-war modern urban development distircts

Surface layout: - distribution of green space, often marginalized
- mediocre ratio of surface sealing

Urban fabric: - high building and population density

Program: - mainly residential, social housing present

Ownership: - housing corporation
- social housing publicity owned

Area of action: - Open & half-public spaces between buildings
- public spaces (streets, squares)

## Public & special typologies areas

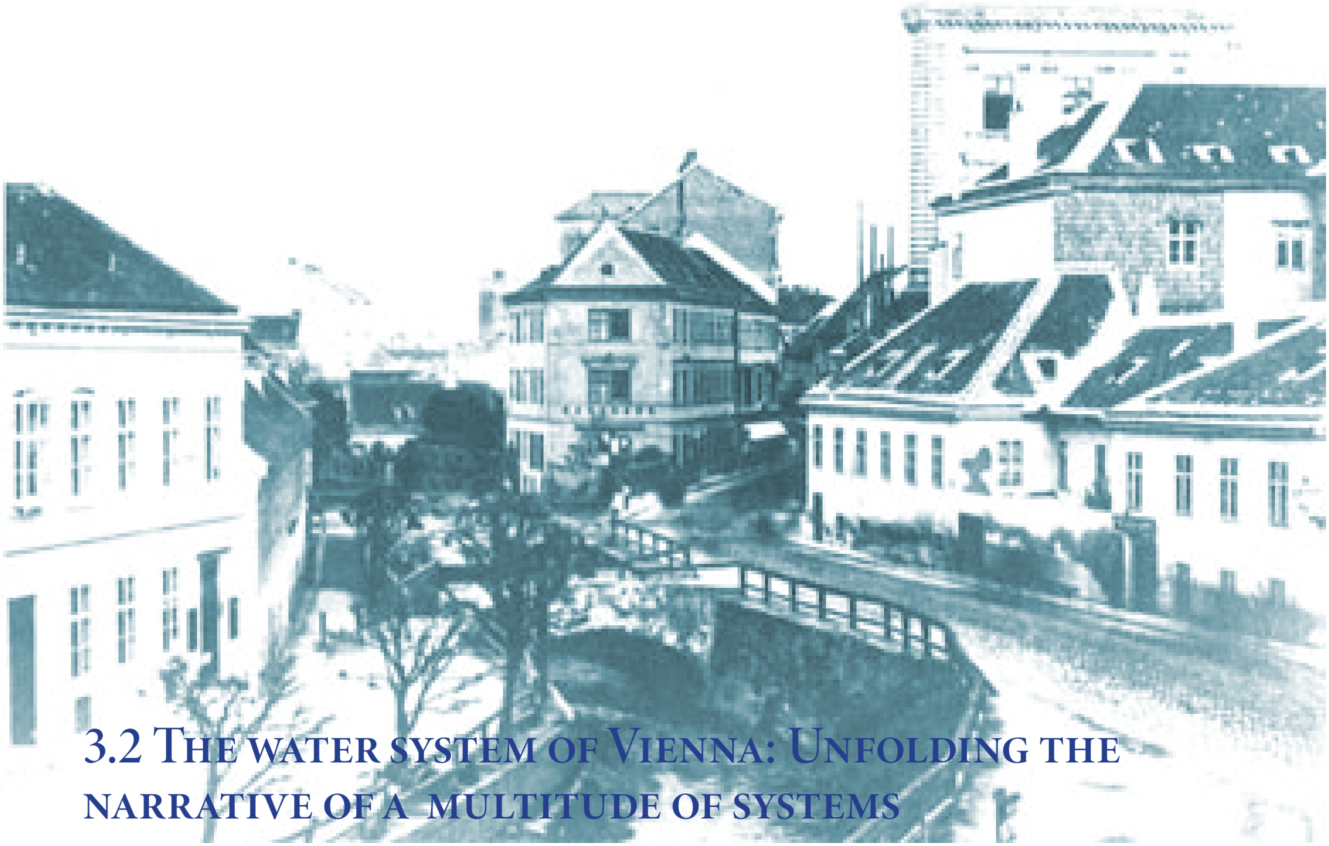
Surface layout: - varying distribution of green space
- high ratio of surface sealing

Urban fabric: - low building density

Program: - public facilities (education, health care, sport, etc.)

Ownership: - publicity owned

Area of action: - Open spaces



## 3.2 The water system of Vienna: Unfolding the narrative of a multitude of systems

[Fig. 71]: Historical Hernalser Hauptstraße

Water plays a pivotal role in Vienna's socio-ecological system, crucial for sustaining both the ecosystem and social structures. To comprehend and unfold its functioning, it is imperative to delve into the intricate network of water systems within the city.

Vienna's water system is a confluence of different systems, including the natural system, the cultural system, and the infrastructural system. The natural system, although significantly shaped by human influence, has left its marks on the cultural landscape. Currently, the water system is largely hidden, canalized, and operates as part of the infrastructural system, not always prominently present in daily life.

### The Natural System

Investigations focus on what remnants of the natural system persist—examining elements like soil, topography, and hydro-morphological types. Understanding the historical original state provides valuable insights.

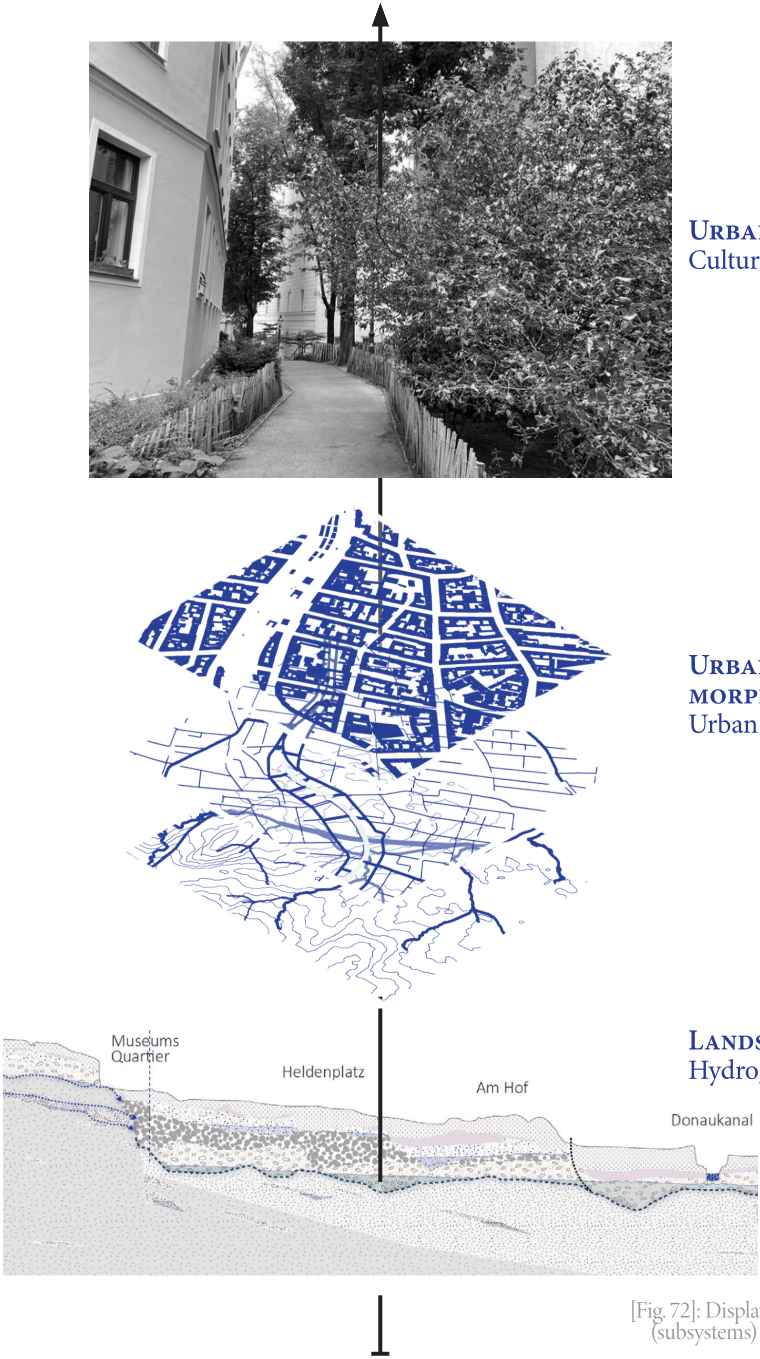
### The Cultural System

The current water system blurs the lines between cultural and infrastructural elements, offering services for recreational purposes. The research explores the overlapping realms between the cultural (recreational), natural and infrastructural water systems, delving into the identity of water in Viennese culture.

### The Infrastructural System

Vienna's infrastructural system conceals the natural water system through canalization. The research delves into how it intersects with remnants of the natural system and interfaces with infrastructures like sewage and mobility.

By exploring these water systems, the study aims to unveil Vienna's water landscape, considering its history, current status, and intricate connections, providing insights for potential transitions.




**URBAN DEVELOPMENT**
Cultural layer

**URBAN MORPHOLOGY**
Urban landscape layer

**LANDSCAPE MORPHOLOGY**
Hydrogeological layer

[Fig. 72]: Displaying different layers (subsystems) of the water system

# 3.2.1 Vienna's water structure

## Topography and the "natural" water system

The Viennese urban area is divided into hydrogeological zones running parallel to the Danube with different groundwater conditions. Starting from the Danube floodplains to the Vienna Woods, from east to west, from the slope to the bedrock, from the younger to the older strata, the following 4 zones can be distinguished (Wiener Gewässer Management GmbH (WGM) 2019):

### Recent gravels in the valley floor of Danube & Wienerwald streams

Age: younger than 11,700 years

Danube valley floor: Here there is very productive, coherent pore groundwater in quartz gravels with great thickness and high water permeability. The Danube valley floor has the greatest water management significance for Vienna.

Valley floor of the Wienerwald streams: Moderately productive groundwater occurs in platy, loamy and therefore less permeable sandstone gravels (WGM 2019).

### Pleistocene terrace gravels of Danube & Wienerwald streams

Age: Ice ages from 2.6 million to 11,700 years ago.

Moderate to low yielding groundwater occurs in them. Exceptions are high-yielding groundwater in the gravel terraces closest to the Danube up to the boundary of the groundwater accompanying stream of the Danube (black/white line), as well as only temporarily occurring, low-yielding water in erosion gullies on the dam surface on the slope from one terrace to the next (WGM 2019).

### Miocene unconsolidated rocks of Vienna Basin

Age: 23 to 5.3 million years old.

In these areas there are rarely contiguous groundwater deposits near the surface, and they are not very productive. Half of this area consists of sands and gravels into which precipitation can seep. In the deeper subsoil, high-yielding, stressed deep groundwaters often occur in several levels. The Miocene silts/clays underlie zones 1 and 2 and form the groundwater dam there (WGM 2019).

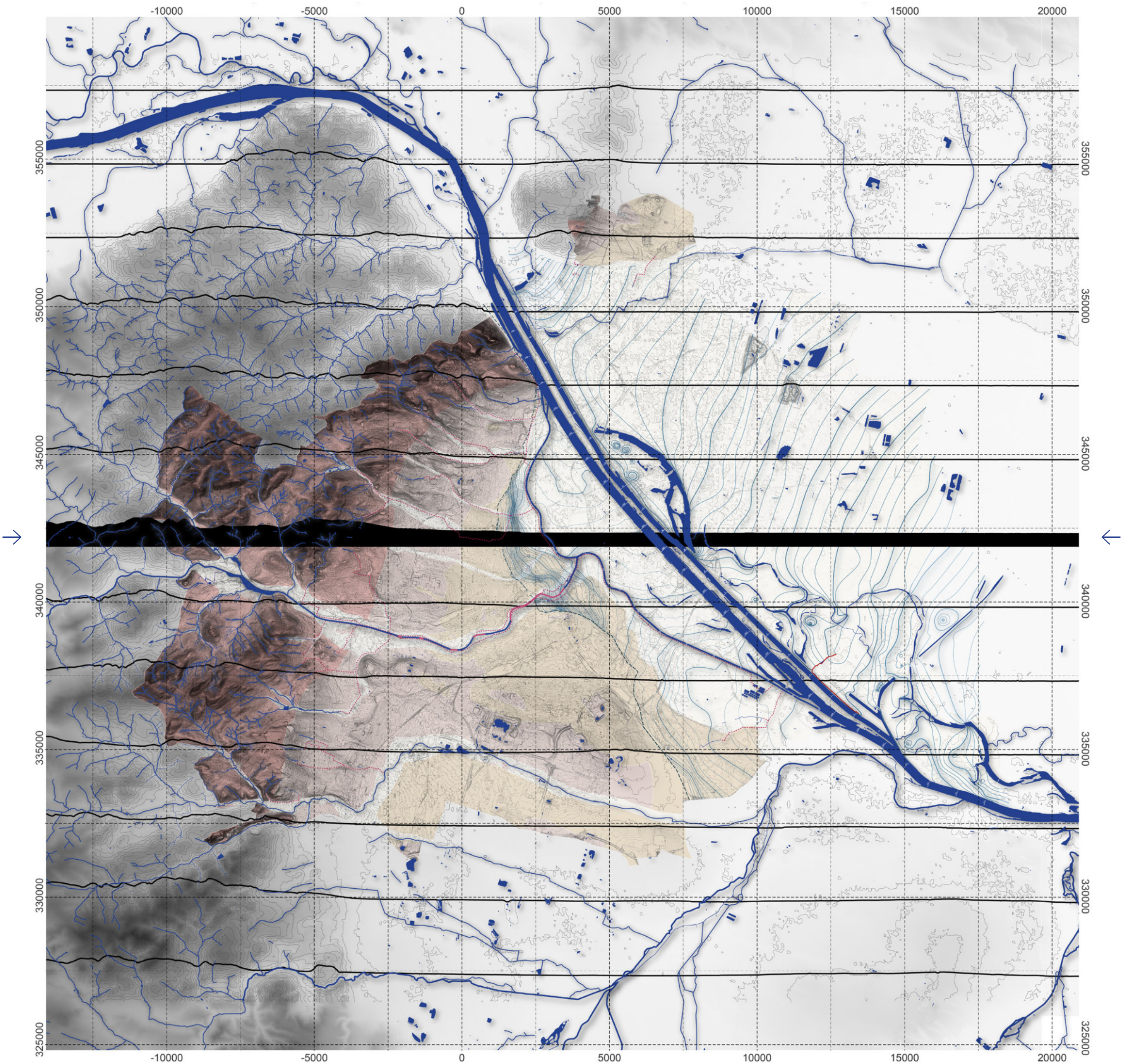
### Alpine bedrock

Age: Calcareous alpine, 270 to 45 million years old and Flysch 100 to 45 million years old.

Locally widespread fissure and stratified waters with varying, but mostly low, yields are found in them (WGM 2019).

Legend [Fig.2]

- Catchment area
- Viennes main waterbodies with Danube (canal) & Wienkanal
- Natural and floating streams
- Covered/ channeled streams
- Groundwater lines (iso-lines) displaying hights and movement
- Border groundwater flow accompanying the Danube
- Terrain section (x2)
- Alpine bedrock
- Miocene unconsolidated rocks of Vienna Basin
- Pleistocene terrace gravels of Danube & streams
- Recent gravels in valley floor & Wienerwald streams




[Fig.73]: Hydrological map with terrain and soil types
*Datasource: Stadt Wien 2023, WGM 2019*

## Soil and groundwater

In the western urban area there is no contiguous groundwater body. The groundwater levels in Vienna are strongly influenced by the Danube and the Danube Canal (Stadt Wien 2023, WGM 2019).

The aquifer of the 1st, 9th and 19th districts lies between the Vienna River and the Danube Canal and is influenced by the water level of the Danube, the Danube Canal and the marginal tributaries. The boundary of the contiguous groundwater with Danube influence is represented by a topographic leap at the hight of the museum district (WGM 2019).

Marginal areas further west lie outside the contiguous groundwater with Danube influence or are measured there as groundwater levels of slope waters influenced by precipitation (Stadt Wien 2023; WGM 2019).

**Groundwater altering interventions:**

When the Freudenau power plant was built, the right bank of the Danube was separated from the surrounding groundwater body by a sealing wall system. Therefore, since 1996, the exchange of groundwater has been simulated by a so-called "groundwater management" depending on the Danube flow. The management of these measures is carried out by Verbund Hydro Power GmbH (VHP).

Another cornerstone is the flow of the Danube Canal, which is regulated by a weir operating regulation. This mainly involves changes in the border area between the 1st, 3rd and 4th districts (WGM 2019).



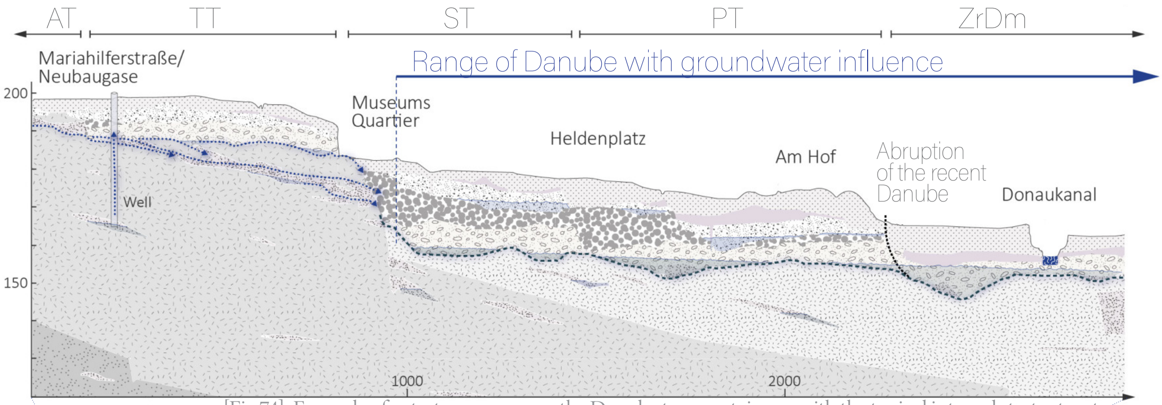
### Notes:

Fig 74 Typical strata structure of loess (loam) over Wienerwald gravel over intercolluvium (= intermediate reservoir) over Danube terrace gravel. Hydrogeological section running from Neubaugasse to the Danube Canal, elevated 10 times, showing the geological subsoil in the city centre.
Danube erosion levels: AT = Arsenal Terrace, TT = Theresianum Terrace, ST = City Terrace, PT = Prater Terrace, ZrDm = Zone of recent Danube meanders); from WGM 2019.

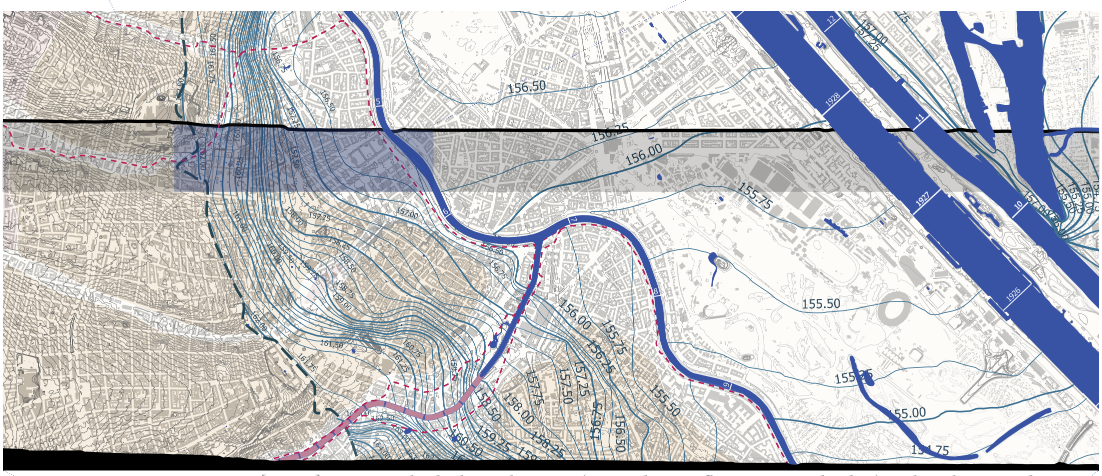
Fig 75 The groundwater lines drawn in are called iso-lines. Along an iso-line, the height of the groundwater level is constant.
The groundwater flow direction can also be read from the plan. It always runs at right angles to a layer line.

Legend [Fig.1]

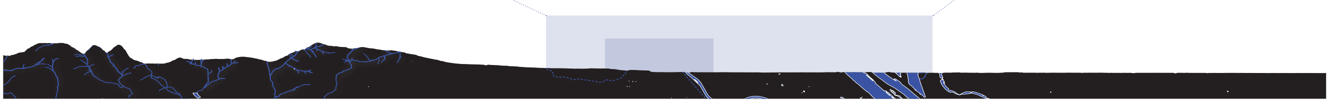
| | |
|---|---|
| Intercolluvium (slope water) | Stratified water. deep groundwater, main groundwater. |
| Danube (terraces) gravel (main groundwater) | Water in Theresianum terrace (influenced by slope water) |
| Miocene sands (contains deep ground water) | Main groundwater. (Danube influenced) |
| Pannonium | Cultural layer |
| Pannonium | Natural cover |
| Sarmatium | Plattel gravel (contains stratified water) |




[Fig.74]: Example of a strata sequence on the Danube terrace staircase with the typical internal strata structure




[Fig.75]: Zoom-in hydrological system (groundwater, floating water bodies) with soil type and terrain



# Vienna's natural floating water bodies

## Danube

The numerous human interventions in the water network of the Vienna Danube did little to counteract the dynamics of the river until the end of the 17th century. The unpredictability of the Danube was based on four factors: the alpine water flow with strongly fluctuating discharge rates, the associated large quantities of transported bedload and suspended matter, the occurrence of extensive ice surges in late winter, and the deposition of tree trunks and rootstocks (deadwood) in the riverbed (Jungwirth et al. 2014, 23).

This resulted in the diversity of the river landscape with its numerous branching, winding and also meandering arms, gravel banks as well as dynamic, ephemeral as well as stable islands. Because of the wide range of aquatic and terrestrial habitats, such "anabranched rivers" are today considered the most species-rich in the world (Gurnell & Petts 2002).



## Vienna River

The first mills along the Vienna River are estimated to have been established around 1100 (Haidvogl et al. 2019). Parts of the mill streams that existed until the middle of the 19th century certainly originated from natural tributaries of the Vienna River. These were extended by connecting shorter arms and raising their beds. The mill streams ran as far away from the actual river as possible so that they could not be so easily eroded by the shifting arms. In phases of increased floods, the Vienna River formed a wide, branched gravel bed, widths of 200 m and more were not uncommon (Reichstein 2016, 78-79).

**Notes:**

[Tab.2]: Mean discharge (MD), before they were integrated into the canal system. The historical discharges refer to the outlets of the streams, the current values to the confluences into the canal system (EZG = catchment area; HQ1 = 1-year flood, HQ100 = 100-year flood; a. v. = value not available) (Haidvogl, Hauer and Hohensinner 2019).

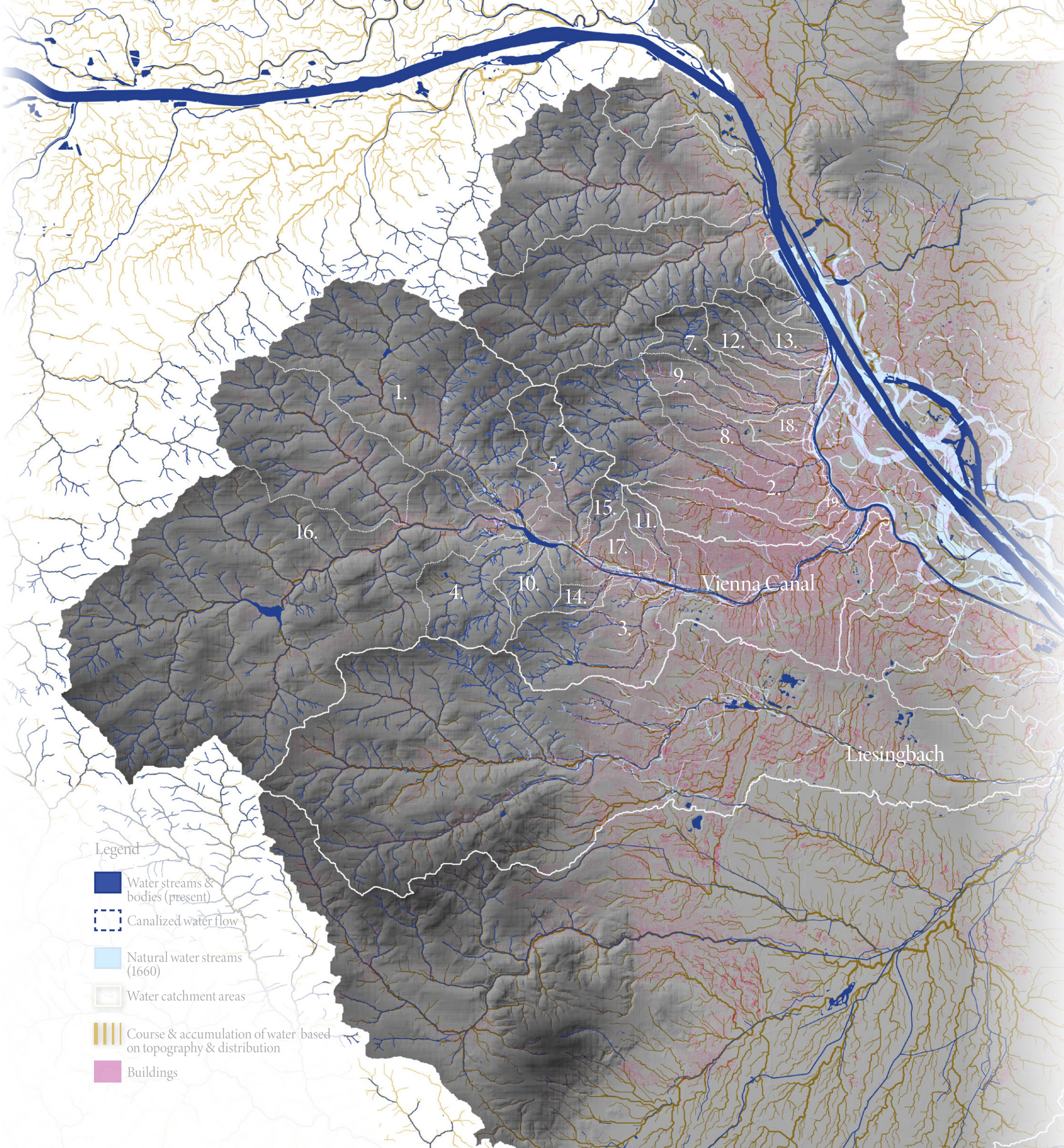
## Wienerwald streams

Vienna's numerous streams pose a challenge to quantify precisely due to their many branching stream systems. Excluding the Vienna River and the Liesingbach, there are 28 significant catchment areas or feeder systems that once emptied into the Danube, the Vienna Arm (Danube Canal), and the Vienna River. Some catchment areas, like Alsbach and Mauerbach, extend beyond the city's current boundaries.

Before a major regulation around 1900, the Vienna River received contributions from eleven tributaries. The Ottakringer Bach, positioned at the junction of the Vienna River valley and the Danube floodplains, could be easily redirected from the Vienna Arm to the Vienna River. Additionally, due to its length and water volume, the Alsbach's waters were redirected into the city during the late Middle Ages. It's noteworthy that all streams where mills operated maintained a minimum discharge of 20 liters per second (equivalent to two buckets of water) (Haidvogl et al. 2019).

| Waterbody | EZG (km$^2$) historical | Length (km) histo./ curr. | MD (l/s) histo./ curr. | $HQ_1$/ $HQ_{100}$ (m$^3$/s) current |
|---|---|---|---|---|
| **Vienna Canal** | 230 | n.a./ 34 | 688/ 393 | 31/ 204 |
| **1. Mauerbach** (VC) | 38,1 | 13,0/ 12,5 | 320/ 300 | 11/ 65 |
| **2. Alsbach** (without 8.) | 18,5 | 12,3/ 2,2 | 150/ 53b | n.a./ 62 |
| **3. Lainzer Bach** (VC) | 14,2 | 8,1/ 3,8 | 90/ <0 | 1,6/ 17 |
| **4. Rotwassergraben** (VC) | 9,3 | 6,5/ 6,5 | 80/ 60 | n.a./ 35 |
| **5. Halterbach** (VC) | 8,4 | 6,2/ 6,3 | 60/ 30 | 1,6/ 33 |
| **6. Ottakringer Bach** | 6,5 | 7,7/ 0,0 | 50/ 0 | 0/ >15 hlst. |
| **7. Erbsenbach** | 5,6 | 6,6/ 2,3 | 45/ 20 | 0,8/ 25 |
| **8. Währinger Bach** | 5,4 | 5,3/ 0,3 | 42/ 4 | 0,2/ 1,7 |
| **9. Krottenbach** (without 7.) | 5,1 | 7,3/ 0,0 | 40/ 0 | 0/ 0 |
| **10. Grünauer Bach** (VC) | 4,2 | 3,2/ 3,1 | 30/20 | 0,8/25 |
| **11. Amelsbach** (VC) | 3,4 | 4,0/ 0,4 | 27/ 1 | n.a./ 1,0 |
| **12. Nesselbach** | 3,6 | 5,2/ 1,1 | 23/ 3 | n.a./ 7,3 |
| **13. Schreiberbach** | 3,6 | 4,9/ 4,2 | 23/11 | 0,8/ 25 |
| **14. Marlenbach** (VC) | 2,4 | 3,1/ 1,2 | 20/ <10 | n.a./ 2,8 |
| **15. Rosenbach** (VC) | 1,8 | 3,1/ 2,5 | 20/ 15 | n.a./ 14 |
| **16. Wurzbach** (VC) | 1,6 | 2,3/ 2,3 | 20/ 15 | 1,2/ 6,5 |
| **17. Baumgartner Graben** (VC) | 2,7 | 2,3/ 0,0 | 18/ 0 | 0/ 0 |
| **18. Schmidtgraben** | 2,1 | 0,7/ 0,0 | 11/ 0 | 0/ 0 |
| **19. Wolfgraben** | 1,7 | 0,7/ 0,0 | 11/ 0 | 0/ 0 |

[Tab.2]: Vienna's former streams ordered by their mean discharge (MD)
[Fig.76, right page]: Catchment areas and water courses of Vienna
Datasource: Stadt Wien 2023



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11.
12.
13.
14.
15.
16.
17.
18.
19.
Vienna Canal
Liesingbach
Legend
Water streams & bodies (present)
Canalized water flow
Natural water streams (1660)
Water catchment areas
Course & accumulation of water based on topography & distribution
Buildings

# 3.1.1 Hydro-morphological patterns of Vienna

Vienna's hydro-morphological landscape comprises natural and artificial water systems, each contributing uniquely to the city's water cycle.

Understanding the hydro-morphological typologies is crucial for sustainable water management and urban planning in Vienna. It underscores the multifaceted roles these water systems play in Vienna, emphasizing the importance of holistic and integrated approaches in managing both natural and artificial elements of the hydro-morphological landscape.

### Natural Water Systems:

The Danube and Danube Canal serve as the primary water distributor, with an extensive catchment area. The Vienna Canal redistributes water locally, connecting to a broader network. Wienerwald Streams, despite their limited flow, play a role in Vienna's hydrology. Disconnected groundwater, influenced by the Danube, and discontinuous groundwater, solely fed by rainwater, contribute to the city's water dynamics.

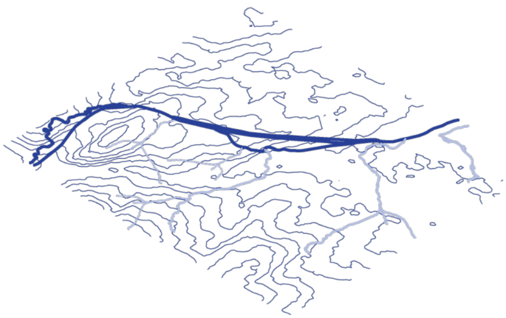
### Artificial Water Systems:

Ponds and baths are primarily cultural water features with no natural inflow. The sewage network manages urban wastewater, impacting water quality and flow patterns.





### Danube & Danube canal

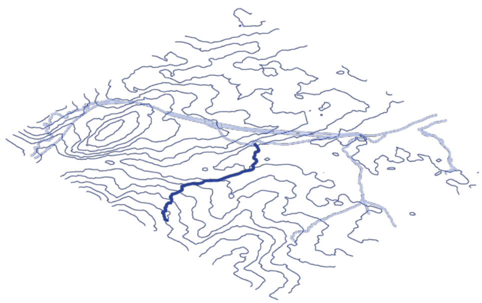


Characteristics: Main distributor of water, extensive regional catchment/inflow area. Very productive, coherent pore groundwater (gw) in quartz gravels with great thickness and high water permeability (WGM 2019).

Role in Water Cycle: Primary conduit for water movement, influencing various regions

Popular recreational and cultural area in the summer, vibrant urban space (canal) contribute to cultural identity and social interaction

### Vienna canal

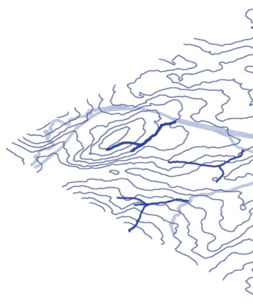


Characteristics: Main distributor to the Danube in Vienna, catchment area expanding to a wider territory. Valley floor with moderately productive Gw in platy, loamy and less permeable sandstone gravels (WGM 2019).

Role in Water Cycle: Central in redistributing water within Vienna, connecting to the broader hydrological network.

Potential to enhance the aesthetic appeal of the urban environment and the cultural experience.

### Wienerwald Strea



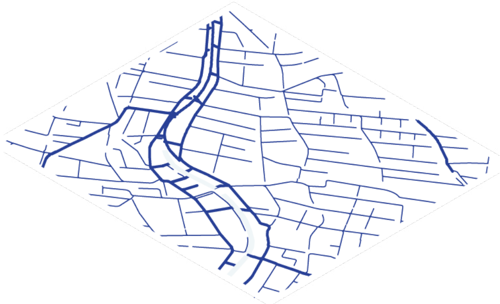
Characteristics: Own catch
borders, low water flow, m
floor with moderately prod
in platy, loamy and therefor
gravels (WGM 2019).

Role in Water Cycle: Feed
Danube, contributing to loca

Potential to serve as green c
the local ecology and cultura

Artificial

## Sewage



Characteristics: Artificial water system, piped infrastructure, receives inflow from wastewater and rainwater disposal (mixed system)

Role in Water Cycle: Manages and directs urban wastewater, impacting water quality and flow patterns.

Serves functional purposes, plays a crucial role in maintaining public health and hygiene.

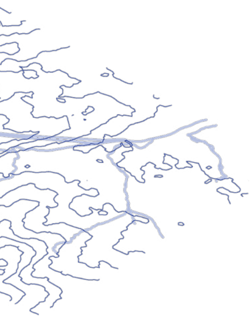
## Ponds and baths

Characteristics: Primarily artificial water bodies with no natural inflow, designed for cultural usage .

Role in Water Cycle: No significant contribution to natural hydrological processes.

Serves cultural and recreational purposes, but also contributes to microclimate regulation, enhancing the quality of life for residents.

## ms



ment area within Vienna's
nainly channelized. Valley
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l into the Vienna River or
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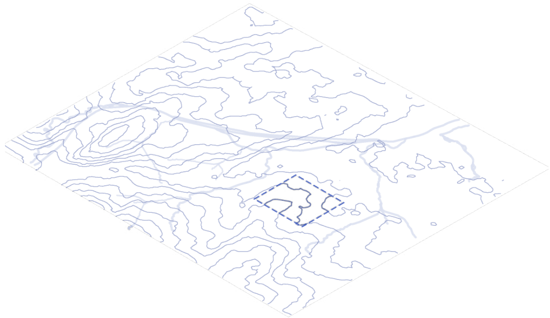
corridors & contributing to
l heritage.

## Disconnected and continous GW

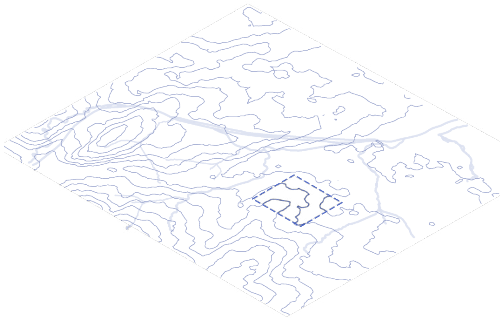


Characteristics: Separated from catchment areas through infrastructure, no network, Gw in quartz gravels with great thickness and high water permeability highly influenced by the Danube (WGM 2019).

Role in Water Cycle: Former Danube floodplain area, impacts local groundwater dynamics.

Challenges for urban development, preserving the groundwater contributes to well-being of hydrological and urban system.

## Disconnected and discontinous GW



Characteristics: Isolated from catchment areas, no hydrological network, rainwater as only natural inflow. Terrace gravels with moderate to low yielding Gw & little infiltration capacity, with exceptions closer to Danube (WGM 2019).

Role in Water Cycle: Discontinuous groundwater dynamics influenced solely by precipitation.

Challenges for urban development, distribution to the groundwater contributes to well-being of hydrological and urban system.

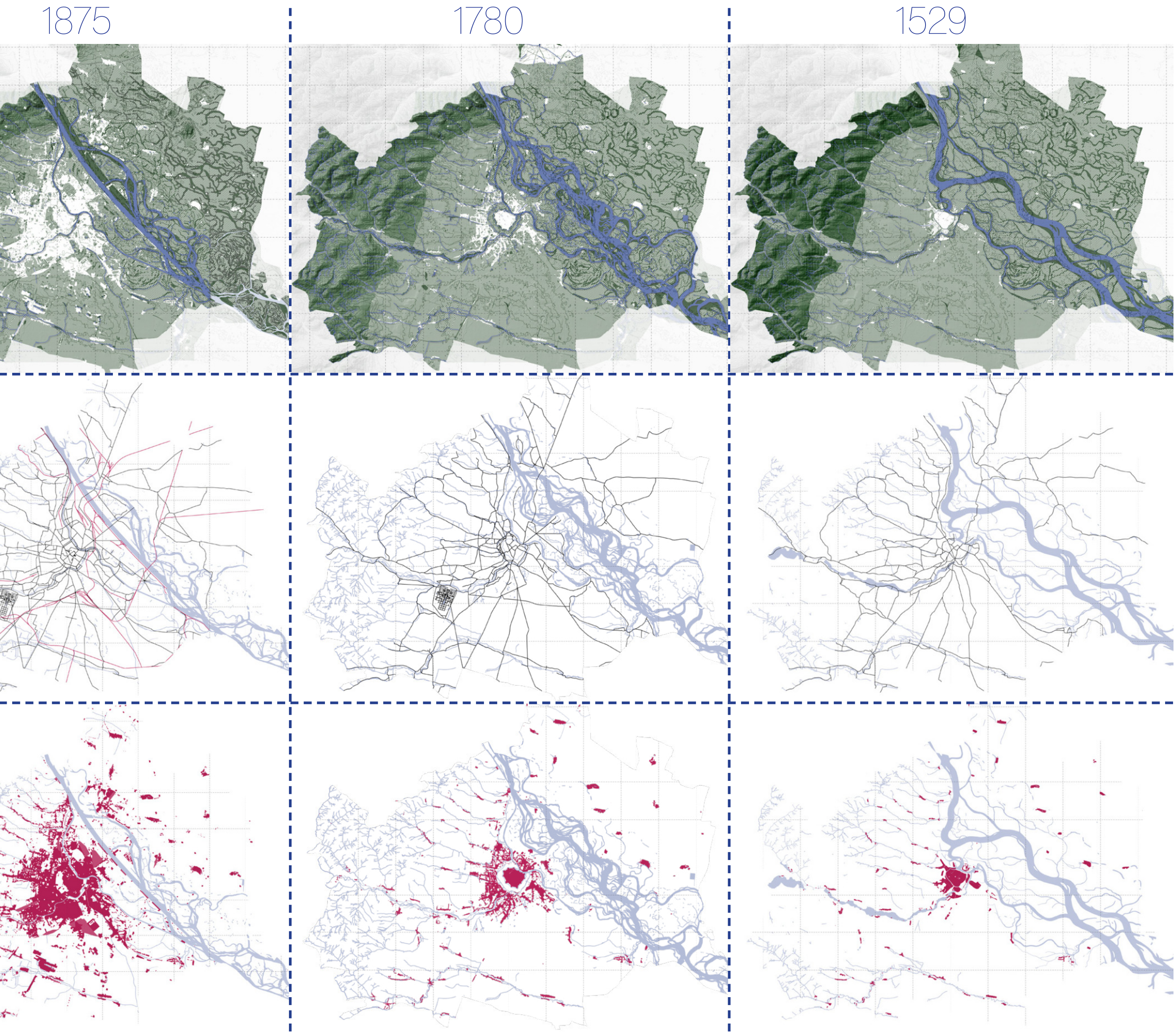
## Blue-green system shaping Vienna

The previously examined landscape and hydrogeological conditions have strongly influenced the development of Vienna.

The area has been inhabited for thousands of years, dating back to the first settlers and later the Romans. Its strategic location at the foot of the Alps, adjacent to the Pannonian basin, provided a favourable climate, freshwater sources, and fertile land for agriculture.

The Danube, coupled with the surrounding topography, not only offered protection from potential threats as well as the river transport and trade opportunities but the numerous streams served as sources of energy for crafts. The fertile Auer soils supported agriculture to sustain the population, while the Wienerwald streams not only supplied freshwater but also facilitated efficient water disposal. Over the centuries, these streams were utilized and redirected for various purposes, including defence strategies. The natural watercourses and topographical features influenced the growth of settlements and the establishment of transportation routes, particularly along the streams originating from the Wienerwald, notably the Vienna River. The extensive regulation and canalization of these water landscapes, created spaces in the urban morphology which persistently served as vital traffic connections, particularly for public transportation. This fostered the dynamic of development along these landscape-formed axes after 1875, further cementing the importance of these axes, not only for transportation but also for other crucial urban systems, such as water supply and disposal.


[Fig.77]:Historical development of blue-green & street system and urban development
*Source: Hohensinner et al. 2012-2023,*


1875
1780
1529

# 3.1.2 Changing usage and relationship to the water system over time


[Fig.78]: Changing use of the water system over time

*Source: Hohensinner et al. 2019*

Vienna's water system remains an integral part of its identity, although its presence and form have evolved significantly. While it may not play the same roles as in the past, the cultural importance of bathing culture persists in Viennese life, fostering connections among residents.

Over time, the water system has shifted from being primarily a natural component to a critical infrastructural element. It has transitioned to serve functional purposes, such as sewage systems and transportation, but also recreationals.

Historically, water has played a central role in shaping Vienna's cultural landscape. The first mills that provided flour and power along the Vienna River are believed to have been established around 1100. These mills relied on natural tributaries of the Vienna River, which were subsequently extended by connecting shorter arms and raising their beds to maximize efficiency and prevent erosion (Hohensinner et al. 2019).

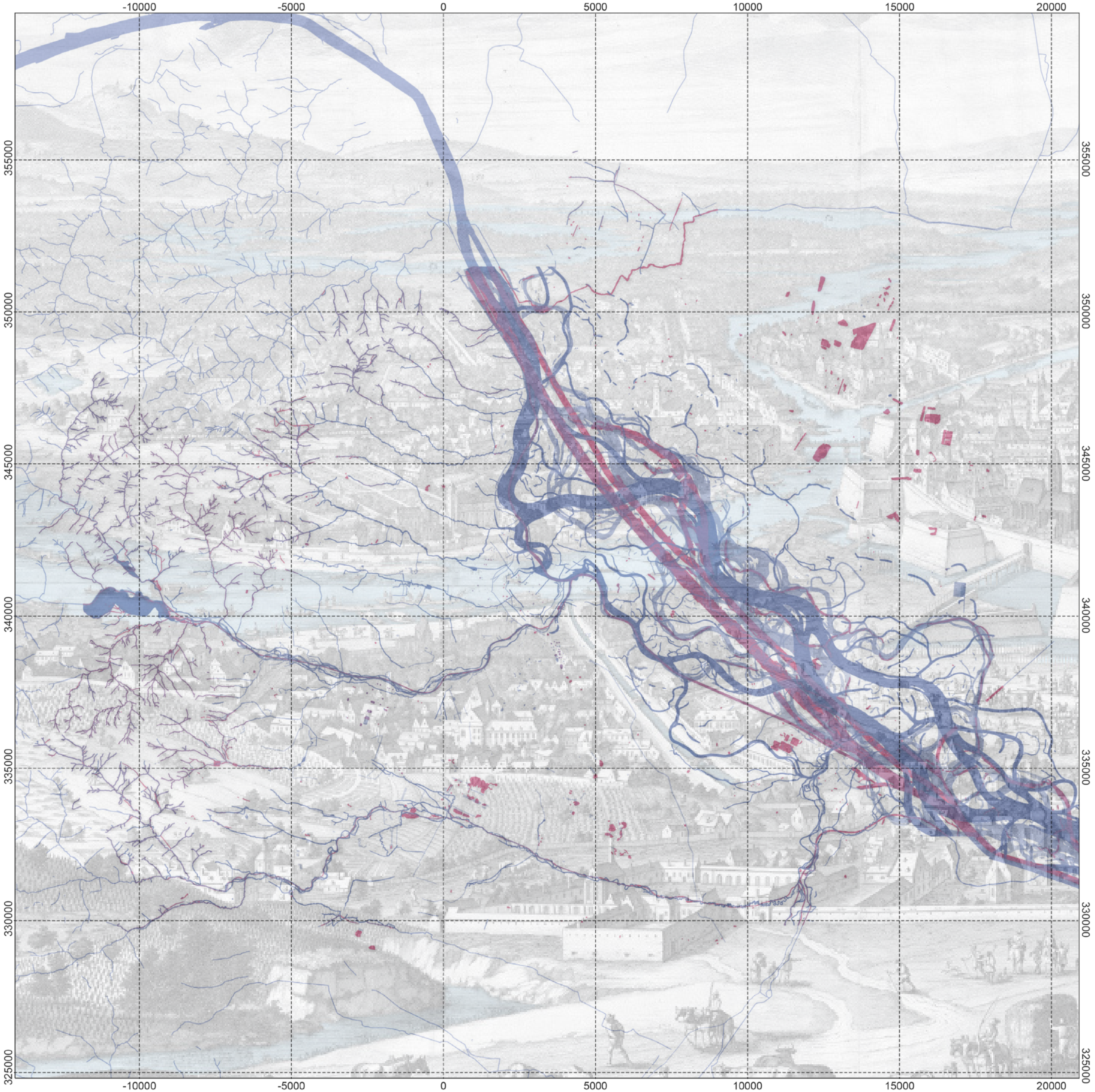
In addition to milling, the Wienfluss and Danube served as popular locations for river bathing. However, the utilization of the Viennese Danube was fraught with challenges due to factors like fluctuating alpine water flow, substantial sediment transport, ice surges in late winter, and the deposition of deadwood in the riverbed (Jungwirth et al. 2014, 23).

Human interventions in Vienna's water network had limited impact on countering the Danube's dynamic nature until the late 17th century. Ultimately, the unpredictability of the Danube, coupled with the sanitary hazards posed by streams used as open sewage systems, led to a shift in behavior towards the water system. This shift resulted in the regulation and canalization of the waterways.




## Notes:

Fig 1 This panoramic view of the cultivated landscape and outskirts of Alsergrund and Roßau, extending to the Viennese Arm, Leopoldstadt, and the Danube floodplains, illustrates the profound impact of human activity on Vienna's water landscape shortly before the Second Turkish Siege around 1683. In the central background to the right, you can see the inner city, and to the far right, the mouth of the Vienna River. The watercourse in the foreground is the Alsbach (Hohensinner et al. 2019).




[Fig.79]: Change of river course 1525 until 2010 overlayed with view of cultural landscape of Vienna around 1683

*Source: Folbert van Alten-Allen 1683*

## Interwoven in the urban system

In Vienna, the traces of the water system persist and occasionally become visible. Though not immediately visible on the surface and tightly regulated, the green-blue system leaves a distinct imprint on the urban landscape, shaping property boundaries and spatial layouts, as seen in areas like Herrenhalser Hauptstraße (A) and Sechshaus (B).

Examination of the mixed sewage system reveals that former watercourses align with primary sewage channels, retaining their historical paths. These watercourses, exemplified by Alserbach (A), and their drainage plays a crucial role in sewage system functionality. Consequently, these watercourses potentially serving as ecosystem corridors for heat mitigation, yet their use presents challenges due to their essential drainage for the sewage system. Rainwater, naturally following previous watercourses based on topography, also offers intervention possibilities.

Major transportation routes often align with historical watercourses, influencing street layouts (A+B) and offering opportunities to synchronize human and ecosystem flows.

In areas lacking these natural and infrastructural features, alternative design interventions must be explored. As part of this ongoing research, Favoritenstraße has been selected as a study area (C). While no natural watercourses exist in this region, topography allows for rainwater drainage and pedestrian use dominates over motorized or public transportation.

Varying hydrogeological conditions affect different soil properties. However, more significantly, the presence of the subway system below limits subsurface utilization.




[Fig.80]:Blue-green system in comparison with the urban systems, like street infrastructure, sewage infrastructure and urban morphology
*Source: Stadt Wien 2023*

MICRO SCALE


[Fig.79]: Change of river course 1525 until 2010
Source: Stadt Wien 2023,

# Development along the water

The green-blue system has been integral to Vienna's urban development, influencing all urban functions and shaping the city's spaces and systems. The challenge lies in harnessing the full potential of these systems, moulded by the city, and the urban systems shaped by the green-blue system. This presents an opportunity to leverage the urban spaces shaped by the natural landscape, fostering a return to development along the water.

Vienna heavily depends on infrastructure for flood control, water management, and improving accessibility, often at the expense of natural processes. Reevaluating this approach and promoting natural or nature-based solutions, while ensuring public accessability, is essential.

To utilize natural water sources like streams, rainwater, and household runoff, currently managed underground in mixed sewer systems, nature-based surface purification methods should be implemented. This allows to establish ecosystem corridors, connecting green spaces and providing valuable ecosystem services.

The alignt mobility infrastructure with historical water flows presents both risks and opportunities. Aligning potential ecosystem corridors with highly frequented mobility routes ensures consistent proximity to ecosystems, thereby emphasizing their value to as many people as possible. However, achieving this goal may necessitate restrictions on motorized individual transportation.

The need for spaces for community, social interaction, and co-production should be met by integrating them within urban ecosystems and in conjuction with ecosystem corridors, fostering experimental and collaborative environments.

***Viennas green-blue system, moulded by the city, and its urban systems shaped by the landscape presents an opportunity to leverage urban spaces, fostering a return to development along the water.***



Legend

Natural areas (forest)

Agricultural used land

Urban (green) parks

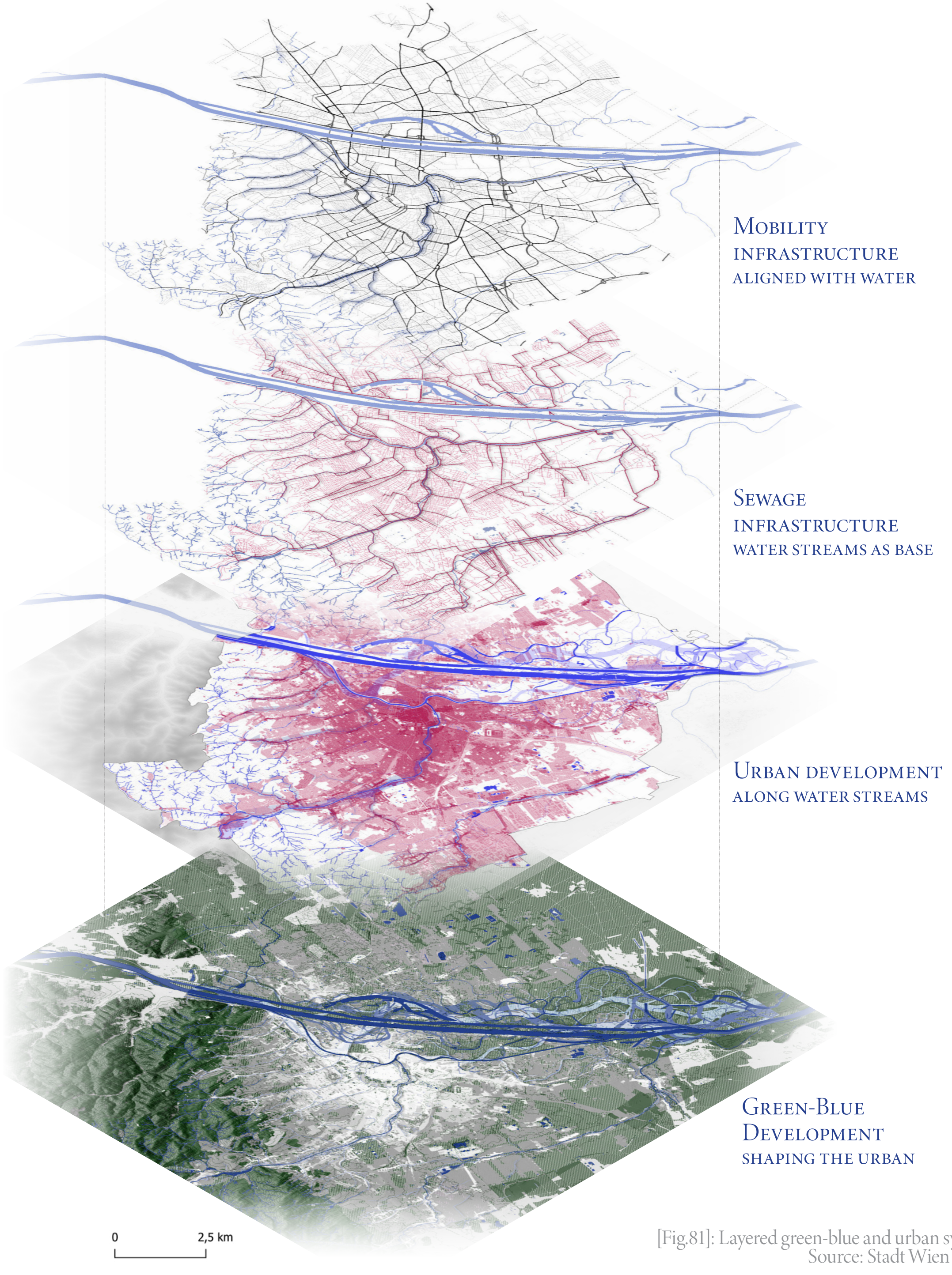
Low density build areas

High density build areas

Urban development

Social housing

Hydrogeological types




[Fig.81]: Layered green-blue and urban system
Source: Stadt Wien 2023,

## Conclusions

### Challenge (present) | Potential (future)

Exchange of natural processes & surfaces through artificial and engineered processes.

Transition towards natural & blue-green systems to benefit from ecosystem resilience & services.

People are mentally and physically disconnected from the ecosystem and its benefits.

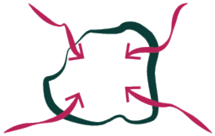
Aligning ecosystem & social benefits/ flows enables to enhance living conditions & reestablish valuing of ecosystems.

Linear water utilization on the cost of the natural water & eco-system.

Drainage by the means of streams to benefit from ecosystem values, utilizing Vienna's unique landscape & urban morphology.

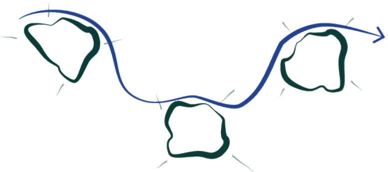
Limited spaces for social interaction, experimentation and stewardship within ecosystem

Fostering the ecosystem as communal infrastructure for co-creation allows activation of public spaces & communal activities.



Dispersed and fragmented green spaces & prioritizing of car-friendly public spaces.

Connecting green spaces & habitats as green corridors through rainwater drainage & redistribution of car infrastructure.



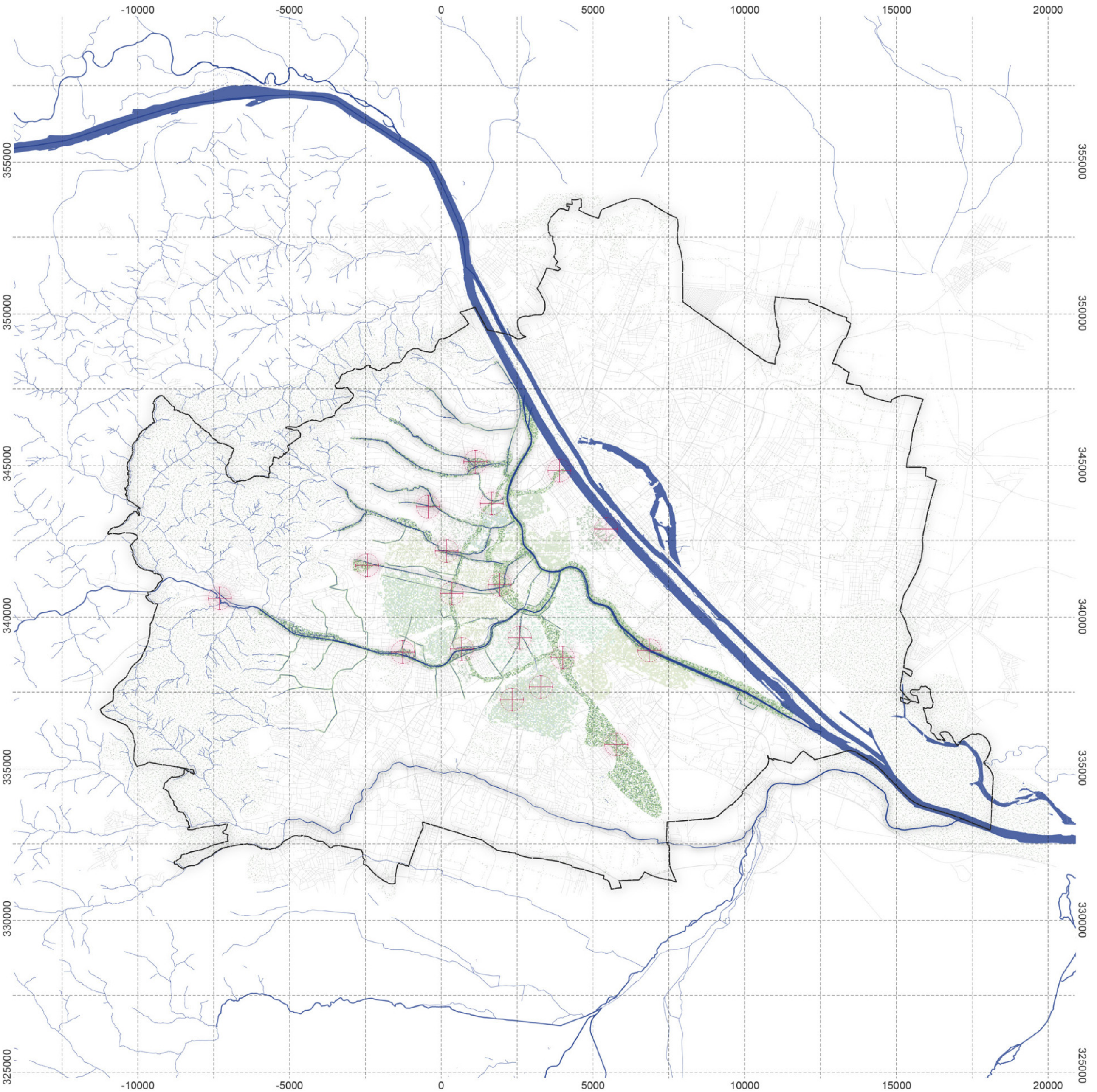
***However, how are these leverages distributed within the social and spatial fabric of the city? Which areas are particularly marginalized?***

Legend

 Integrating green/ ecosystem values, fostering robust ecosystems.

 Blue-green corridors connecting & creating green spaces, utilizing streams & water runoff.

 Social amenities & communal spaces integrated into & complementing blue-green infrastructure.




[Fig.82]: Conclusive map showing potential transformation




# 3.3 The social system of Vienna: Vulnerabilities and interdependencies

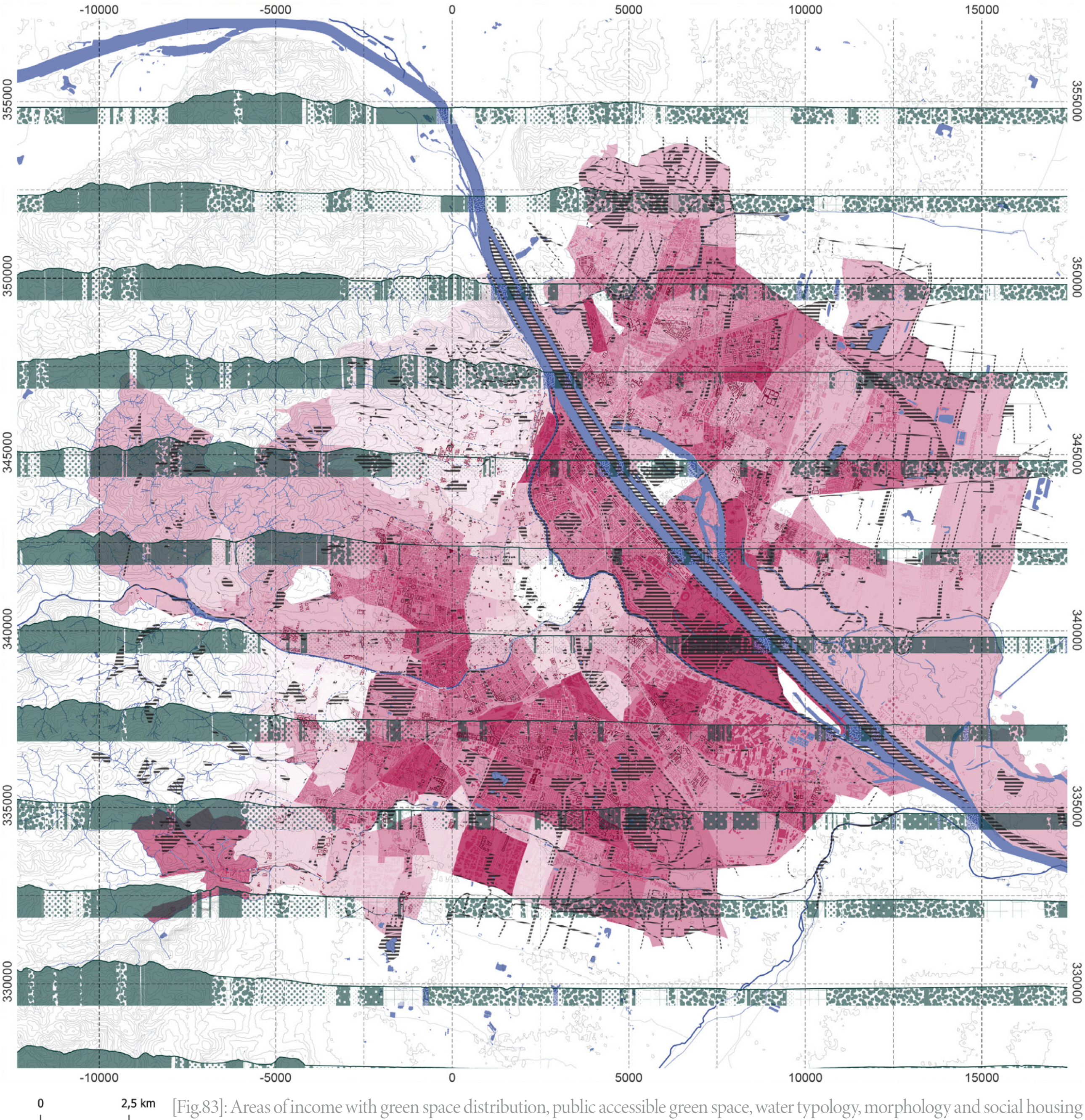
As shown on the map and supported by previous analyses, it is evident that certain areas of Vienna, particularly those with low-income and marginalized populations, face challenges related to inadequate access to green spaces, which subsequently exposes them to climate-related hazards. Within the context of environmental justice initiatives, a central focus of this thesis is the equitable distribution of resources, benefits, burdens, and opportunities associated with green spaces, as advocated by Haase et al. (2023).

This emphasis shifts toward Vienna's low-income neighborhoods, which are characterized by rich cultural diversity and residents with migration backgrounds. This unique composition renders them particularly vulnerable to various forms of injustice. These injustices include procedural injustice, resulting in limited participation in decision-making processes, and interaction injustice, characterized by discriminatory interactions among residents. Such interactions often fail to address the needs, values, and preferences of these residents within a safe and equitable environment (Haase et al. 2023).

Furthermore, to proactively mitigate green space gentrification, the research is centered on areas with a substantial presence of social housing. These areas are safeguarded from gentrification due to their ownership structure and offer simplified intervention options for public authorities.

Legend

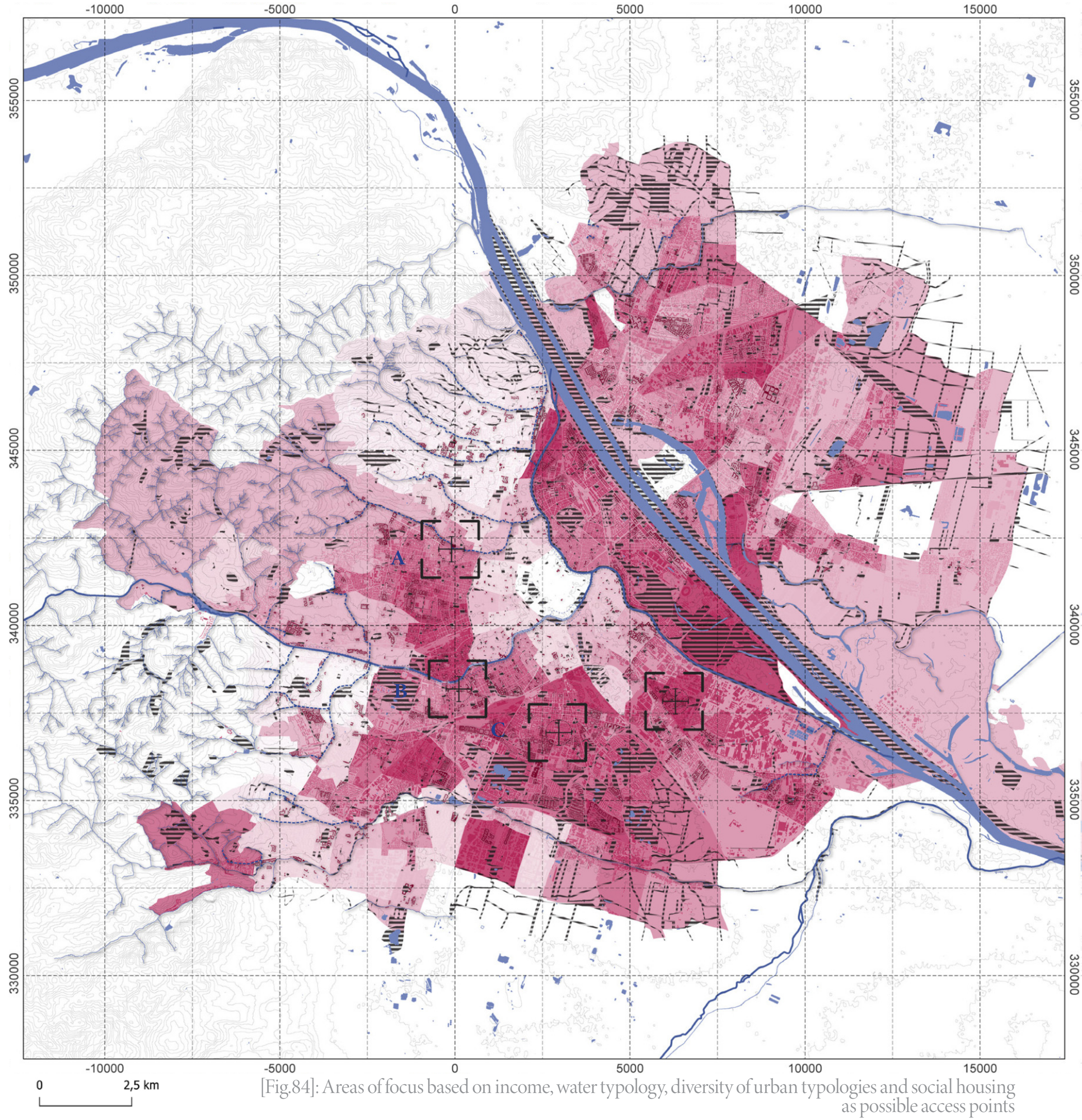
- Natural areas (forest)
- Agricultural used land
- Urban (green) parks
- Low density build areas
- High density build areas
- Industrial areas
- Low to higher yearly income by subdistrict
- Social housing
- Hydrogeological types
- Public accessible parks




[Fig.83]: Areas of income with green space distribution, public accessible green space, water typology, morphology and social housing
*Datasource: AK Wien 2018, Stadt Wien 2023, EEA 2018*

# 3.3.1 Designing a just climate resilient transition

## Areas of focus and their characteristics




[Fig.84]: Areas of focus based on income, water typology, diversity of urban typologies and social housing as possible access points

*Data source: AK Wien 2018, Stadt Wien 2023*

## A | Hernalser Hauptsrasse

Hydro-morphological type:
- stream
- terraced ground

Urban typology:
- Mainly gründerzeit block, spacious block, special public type

Social housing:
- little

Income:
- low-medium mixed

## B | Vienna canal - Sechshaus

Water type:
- Vienna canal

Urban typology:
- Mainly gründerzeit block, modern post war development

Social housing:
- available

Income:
- Very low-medium

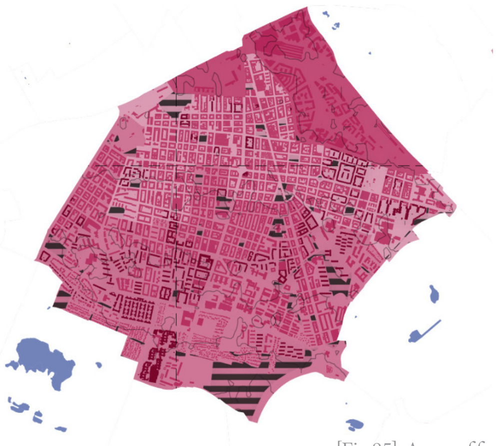
## C | Favoriten

Water type:
- dry and disconnected

Urban typology:
- Mainly gründerzeit block, modern post war development, spacious block

Social housing:
- high

Income:
- Very low



[Fig.85]: Areas of focus

# 4. Design Framework &

## 4.1 Developing Design Princ

## 4.2 Design Exploration

# & Exploration

## CIPLES

# 4. Design Framework

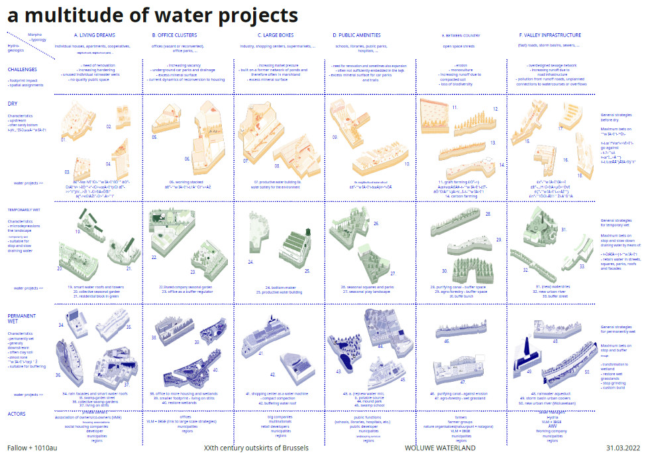
Research by design process involves the systematization of urban patterns. This includes the specification of various types, which are determined by considering hydro-morphology (landscape morphology) and urban morphology as key factors. The selection of case studies is driven by the objective to encompass a wide spectrum of hydrological conditions and urban morphologies, encompassing socio-economic vulnerabilities.

Within these case studies, a comprehensive design investigation unfolds. This investigation is a multifaceted process that includes design activities, literature research, and a process of deconstruction and reconstruction.

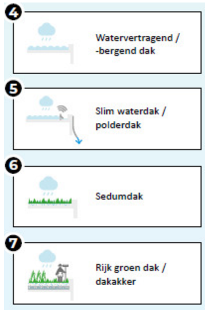
This design exploration is conducted first via mapping to define urban, landscape and social characteristics of the research areas, establishing a cohesive district-wide strategy and design concept. Subsequently, detailed analysis and the integration of interventions are explored via sections. These sections enable a layered approach at the street scale, displaying values throughout the green, blue and social systems.

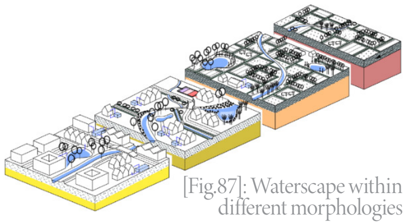
The ultimate goal is to develop exemplary interventions that hold the potential for transferability to other locations within Vienna. These interventions are encapsulated in the form of design principles, allowing for a systematic and strategic approach to address urban challenges.

Through the multiplication and refinement of these principles, an assemblage of design elements, fostering the integration of a social green-blue network, towards a climate-resilience Vienna, is displayed

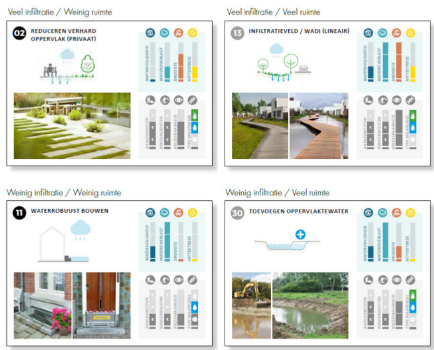



[Fig.86]: Water interventions



[Fig.87]: Waterscape within different morphologies




[Fig.88]: Stormwater design principles

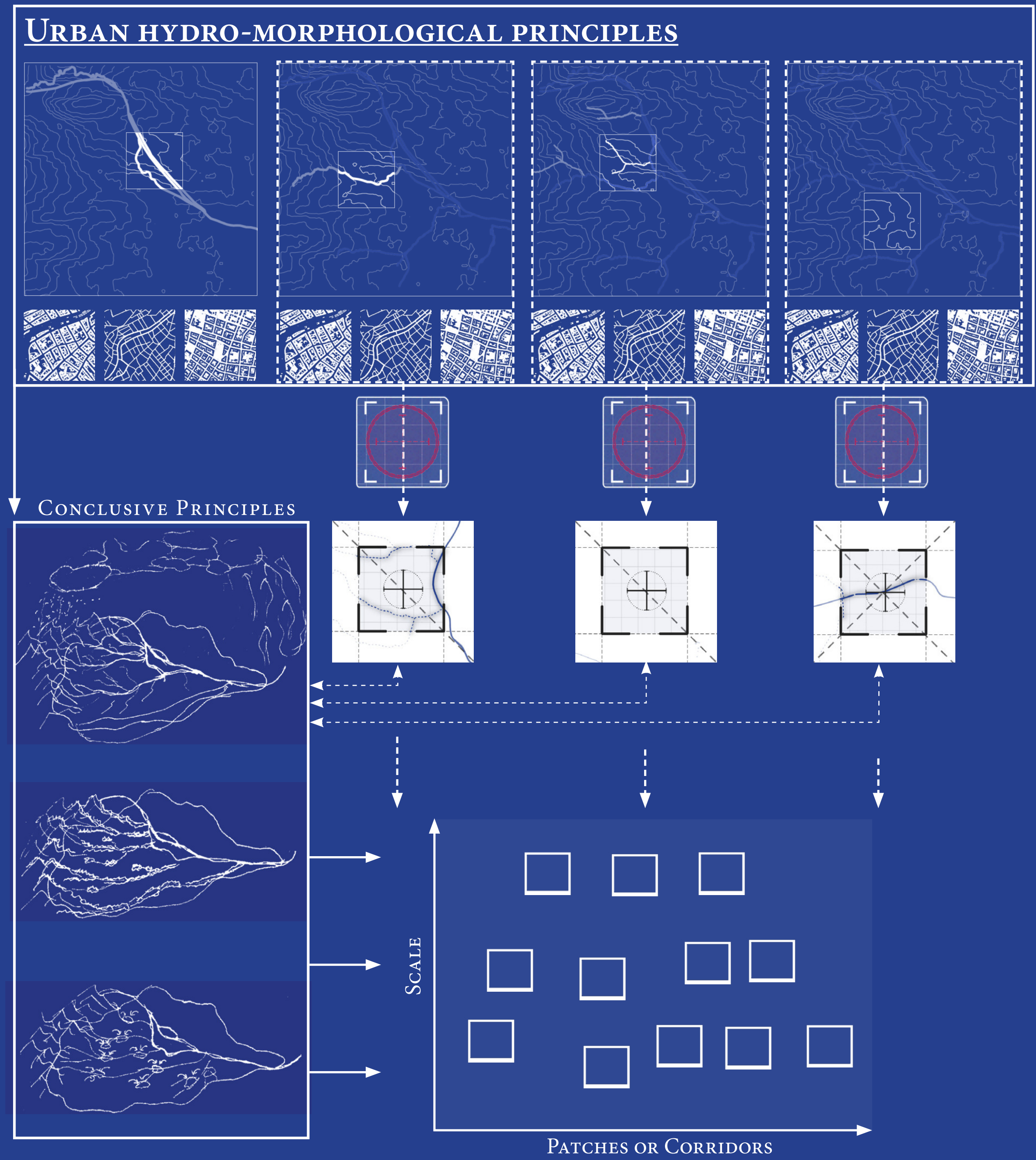
[Fig.89]: Elements of design throughout watershed

## Notes:

[Fig 86+89]: Source: Woluwe Waterland - fallow + 1010au, 2022

[Fig 87]: Source: L'Espace Bleu Eurométropolitain - Studio 8 Paola Viganò, Chiara Cavalieri 2015)

[Fig 88]: Source: Waterplan Antwerp, De Urbanisten 2018


Urban hydro-morphological principles
Conclusive Principles
Scale
Patches or Corridors

# 4.1 Developing Design Principles

The following chapters establish principles with practical implications. These proposed solutions, facilitating the transition from systemic to programmatic changes, have the potential to instigate alterations in land use.

Recognizing the impact of contextual dynamics on specific principles and their practical implications is crucial. Understanding the interrelation of theories with practices, solutions, and corresponding principles is essential. This chapter aims to elucidate these relations by systematizing urban form and generating design principles regarding to research theories, case studies and interviews as design elements of climate-resilient city.

Functioning as a tool, it conceptualizes the intertwined urban and landscape morphology of Vienna, considering local social demands. It simplifies the complexity of the local context into abstract and queryable elements. This system streamlines complexity and aids in the subsequent design process, using a layered approach to highlight added value within different systems—green, blue, and social.

This approach arises from two distinct needs: (a) comprehension and potential control of a complex system; (b) creation of essential design tools for constructing something functionally and structurally coherent (Salingaros, 2000). These principles and systematizations serve as the foundation for further design exploration and enhance transferability. They facilitate the synthesis of findings into conclusions and design interventions.

## Evaluation

### Timeframe

Estimated value based on feasibility, required engineering measures, ownership and necessary systemic changes (effort).

short-term (ca. 1-5 years)

mid-term (ca. 6-15 years)

long-term (ca. 16-30 years)

### Source

Theory

Case studies

Best-practice

### Systemic values

Principle contributes to:

Green System

Integration and connection of ecosystems

Blue System

Natural water cycle management

Social System

Ecosystem as communal infrastructure fostering interaction & awareness

### Integration and connection of ecosystems

The approach centers on integrating ecosystems and their services into the built environment through a green network. This includes establishing green corridors in neighborhoods, ensuring multifunctionality of spaces, strengthening urban parks as ecosystem patches, and promoting shared and communal public space use through enhanced eco-mobilities.

**Ecological Urbanism, Urban Ecology, Biodiversity Sensitive Urban Design**
Andersson et al. 2019; Hansen et al. 2019; Ian McHarg 1996; Waldheim 2016; Kirk et al. 2021

**In practice**
CIPRA 2010, Russo et al. 2023, UNaLab 2019, World Bank 2021



### Natural water cycle management

This principle integrates water-cycle management into the urban space, encompassing the integration of infrastructural, environmental, and social systems. It addresses the comprehensive management of stormwater by the means of streams, and water retention & detention areas

This approach spans various scales and includes structural elements, such as infrastructure development, like daylighting, and non-structural components like governance.

**Water-sensitive urban design**
Wong 2006; van der Meulen, Van Dorst, Bacchin 2023

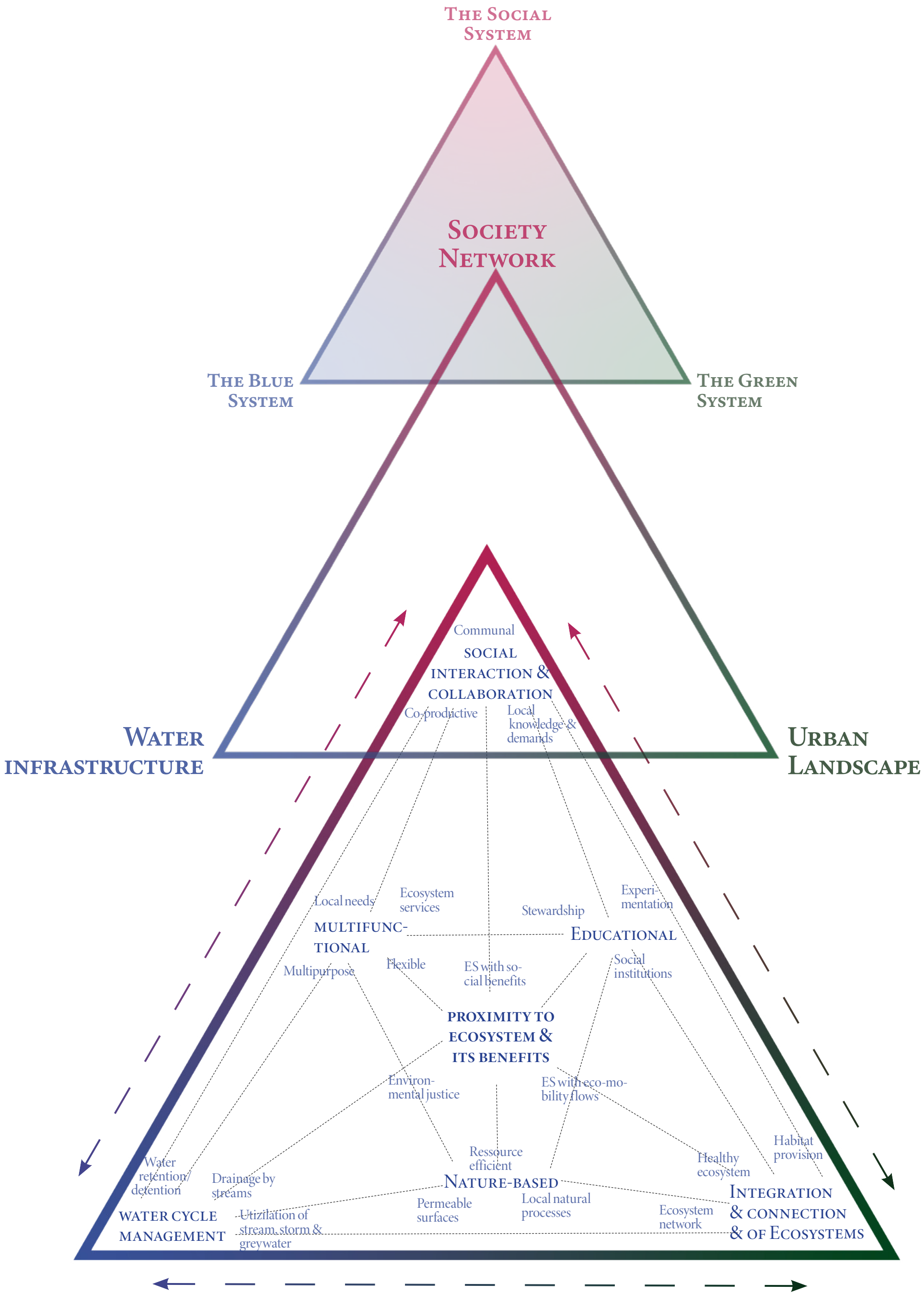
**In practice**
Prominski et al. 2017, Officials 2017, Slaney 2017, Steenbergen 2008, Zumsteg et al. 2016

### Fostering awareness and reconnecting people to ecosystem services

The principle centers on raising awareness and reconnecting people to ecosystem services, especially in areas lacking green-blue infrastructure. The goal is to promote environmental justice and knowledge systems for vulnerable populations by aligning ecosystem benefits with social advantages and strengthening public institutions.

In the design framework, local demands are identified, and the green-blue network is established as a multifunctional social infrastructure. It caters to educational, communal, collaborative, and recreational needs while integrating productive elements. This approach allocates space for experimentation and learning, emphasizing co-creation. Fundamentally, it prioritizes the stewardship of ecosystem services, aiming to create urban environments that harmonize with nature.

**Societal resilience**
Andersson et al. 2014; Folke 2016;
**Environmental justice**
Haase 2014
**In practice**
Vigano, Secchi

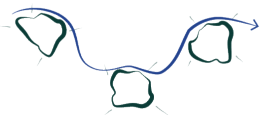


The Social System
Society Network
The Blue System
The Green System
Water infrastructure
Urban Landscape
Communal
social interaction & collaboration
Co-productive
Local knowledge & demands
Local needs
Ecosystem services
Stewardship
Experi-mentation
multifunc-tional
Educational
Multipurpose
Flexible
ES with so-cial benefits
Social institutions
proximity to ecosystem & its benefits
Environ-mental justice
ES with eco-mo-bility flows
Water retention/ detention
Drainage by streams
Ressource efficient
Healthy ecosystem
Habitat provision
Nature-based
Integration & connection & of Ecosystems
water cycle management
Utizilation of stream, storm & greywater
Permeable surfaces
Local natural processes
Ecosystem network

# Main design principles

## Integration and connection of ecosystems

### Connecting green spaces



#### Green corridor

Ecological corridors (strip of habitat) continuously connect (core) ecosystems to create a green network, providing ecosystem benefits (cooling, recreation, etc.) & improving biodiversity.

Prerequisite:
- combination with natural rainwater drainage

**Main green corridor**

Main green corridor connecting core ecosystems continously; patches connected to it.

Prerequisite:
- existing stream to develop streamscape or existing corridors
- core ecosystems to connect

**Multitude of green connections**

(Diverse) green corridors, connecting green patches & core ecosystems with minor interruptions.

Prerequisite:
- Main corridor & drainage not feasible (barriers)
- Connection of existing green patches

#### Green connector

Green connections with limited connectivity may not always be combined with rainwater drainage. These connections may not form a continuous pathway but can consist of green steppingstones or islands in close proximity.

Prerequisite:
- green corridors & patches

**Interlink**

Green connections are interlinked to the main green corridor to establish a network.

Prerequisite:
- main green corridor
- redistributing street space

**Interconnect**

Connections between patches or nodes serve to interconnect and form a network.

Prerequisite:
- patches as nodes
- redistributing street space

### Urban space as ecosystem

#### Ecological urban patches

Urban patches are nodes in a green-blue network and kept naturally as biodiverse habitats, emphasizing the integration of vegetation featuring native species. The principle necessitates high connectivity with other patches

Prerequisite:
- open space
- combination with water detention/ retention

**Parks as natural nodes**

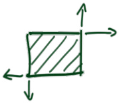
Patches with low density, like Parks, are kept as natural as possible, with wild & unmown vegetated areas.

Prerequisite:
- low density and low sealing

**Squares as green nodes**

Patches with high density or sealing provide, although their limited capacity, biodiverse vegetation, unsealed areas & a continous green connection.

Prerequisite:
- medium to high density or sealing



#### Linear ecosystems

Linear spaces like streets are utilized to provide ecosystem benefits & connecting green spaces & habitats. Even narrow streets have vegetation & open surfaces integrated.

Prerequisite:
- Redistribution of parking/ car space

**Green corridor**

Continuous & capable of consistently serving as a habitat.

Prerequisite:
- existing stream for streamscape or biotop corridor
- shared communal space

**Green connector**

Green islands located closely (-15m), akin to green buffers & stripes.

Prerequisite:
- green patches to connect
- shared communal space

### Shared communal space

#### Eco-mobility concept

To establish a green-blue network, a fundamental reimagining of public spaces is imperative. The cities mobility concept targets a modal split of 85% journeys eco-mobility, and 15% by private motorized transport until 2030.

Prerequisite:
- qualitative eco-mobilities

**Parking space reduction**

The cities objective is to decrease private car ownership to 250 vehicles per 1000 inhabitants until 2030

Prerequisite:
- collective and temporary parking
- city's mobility concept

**Ecosystem & eco-mobility values**

Aligning green and eco-mobility connections. Integrating bicycle and public transport connections into the green-blue network.

Prerequisite:
- green & mobility net overlapping

#### Car-poor Supergrätzel

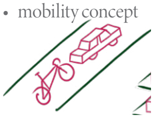
Superblocks (Supergrätzel, tested in Favoriten), as car-poor neighborhoods within designated 30 km/h - zones are introduced.

Prerequisite:
- 30 km/h-zones; city's eco-mobility concept

**Shared streets**

Streets in 30 km/h zones as shared spaces for all means of transport.

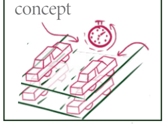
Prerequisite:
- 30km/h-streets
- mobility concept



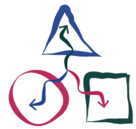
**Collective & temporary parking**

Promote mobility shift with temporary parking zones/collective parking stations.

Prerequisite:
- eco-mobility concept



### Multifunctional surfaces



#### Breathing surfaces

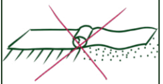
To enhance soil quality and its capacity for microorganisms & infiltration, promoting ecosystem benefits, it is imperative to leave open surfaces unsealed whenever feasible. Additionally, when paving is unavoidable, opting for permeable pavements is essential.

Prerequisite:
- contextualized interventions

**Stop sealing surfaces**

No further areas are sealed by contextualised measures, as sealing permanently destructs soil capacity.

Prerequisite:
- contextualized interventions



**Permeable surfaces**

The use of a variety of water-permeable paving reduces the amount of sealed surfaces.

Prerequisite:
- experimenting with new techniques in urban environments

#### Multifunctional infrastructure

Ensuring the multifunctionality of areas and interventions is crucial to secure multiple systemic benefits. However, it is necessary to establish systemic focal points per intervention.

Prerequisite:
- evaluation of multifunctional potential
- systemic focal point

**Social focus**

Focus on communal & social benefits, ensuring qualities for human users at all times.

Prerequisite:
- social corridor
- high pressure of use
- proximity to social institutions

**Green-blue focus**

Focus on ecosystem & water drainage benefits, allowing flooded or wild vegetated areas.

Prerequisite:
- only green-blue connection
- already natural areas

# Natural water cycle management

## Drainage by streams

### Utilization of stream/ rainwater

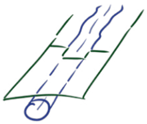
Natural surface water drainage via streams, canals, or wider waterscapes, through harvesting of stream & runoff water to supply & provide ecosystem benefits.

Requirement:
- slope/ elevation
- suitable sub-soil conditions (saturated soil)

#### Daylighting

Opening of former streams and reintegration into public space as stream.

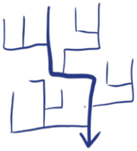
Prerequisite:
- canalized stream



#### Rainwater drainage

Natural rainwater drainage by guiding the water through the public space, via canals, swales, etc.

Prerequisite:
- spatial capacity.



## Local water containment

### Water detention & retention

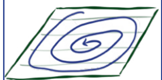
To manage runoff, prevent flooding, & harvest water for dry periods, various methods are employed, including storing, slowing, or infiltrating water through ponds, periodic wetlands, (terraced) basins, retention stripes, swales, or underground reservoirs.

Requirement:
- accumulation of water

#### Water retention patches

Patches are used as water retention & floodable areas (if feasible) through constructed wetlands, ponds, (terraced) basins or undergound reservoirs.

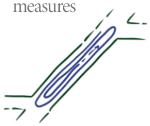
Prerequisite:
- suitable topography or building measures



#### Linear water retention

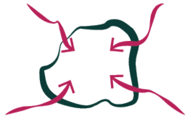
Corridors are used for water detention , retention & overflow areas via retention stripes, (terraced) swales or basing (flooding).

Prerequisite:
- suitable topography or building measures



# Ecosystem as communal infrastructure

## Communal infrastructure



### Ecosystem with social benefits

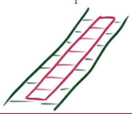
Providing social value along green-blue infrastructure , based on local demands & neccessities, to improve potential human-nature interactions & show value of ecosystems.

Prerequisite:
- overlapping of social & green connections

#### Social infrastructure

Proximity to schools & kindergartens: educational value, social housing areas: communal & recreational, commercial & central areas: gathering spaces & productive benefits.

Prerequisite:
- identifying demans via participative & accessible proccess



#### Aligning eco-mobilities

Aligning eco-mobility initiatives with ecosystem benefits, especially in areas with high commuting activity or social networks.

Prerequisite:
- lack of bike routes/ public transport
- alignment of green patterns with mobility routes

## Fostering social institutions

### Ecosystem as just instrument

Promoting a just transition involves prioritizing areas with lower income & fewer private spaces, such as social housing neighborhoods in low-income areas, as well as vulnerable demographics like young people.

#### Prioritizing educational institutions

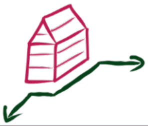
Prioritizing educational facilities to promote the appreciation of ecosystems, ensure safe school routes & upgrade public areas.

Prerequisite:
- local demands & low income
- alignent ecosystem & social benefits

#### Prioritizing social housing districts

Prioritizing social housing districts to upgrade living conditions.

Prerequisite:
- low income areas



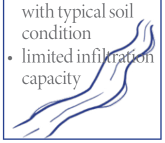
### Guiding the water

In dense urban or linear spaces, a semi-hard edge with an open sole is common, while patches and natural areas typically have more natural riparian zones.

#### Stream

Natural stream with natural shores to allow meandering.

Prerequisite:
- natural stream with typical soil condition
- limited infiltration capacity



#### Canals & Swales

Artifical canals & swales with hard or semi-hard edges to guide water.

Prerequisite:
- slope

### Redirecting the water

To merge drainage streams, retent water and curb water systemic hazards, water is directed towards main retention areas.

Requirement:
- accumulation of water (topography)

#### Change of waterflow

Artificial water reservoirs and basins are strategically employed within patches and streets to alter the natural flow of water. The diversion is facilitated by accumulating it through damming measures.

Prerequisite:
- terracing, damming or soil excavation

### Space activation

Activation of (public) spaces through participative & co-creative activities, fostering stewardship & the ecosystem as communal infrastructure.

Prerequisite:
- local communities, social initiatives, or institutions

#### Participative process

A participatory process initiated by the municipality enables the activation and shaping of green-blue infrastructure in accordance with local needs.

Prerequisite:
- public initiative

#### Co-creation

Local initiatives & distribution of spaces for small scale green-blue interventions to uplift neighbourhood ("Grätzeloase").

Prerequisite:
- social initiatives & public funding

### Ecosystem stewardship

Promoting ecosystem stewardship & maintaining green-blue infrastructure requires collaboration and engagement from diverse groups.

Requirements:
- comprehensive management plan, overseen by
- core group,

#### Social/ public institutions

Engaging young community members through collaboration with kindergartens, youth centers, and schools for educational purposes.

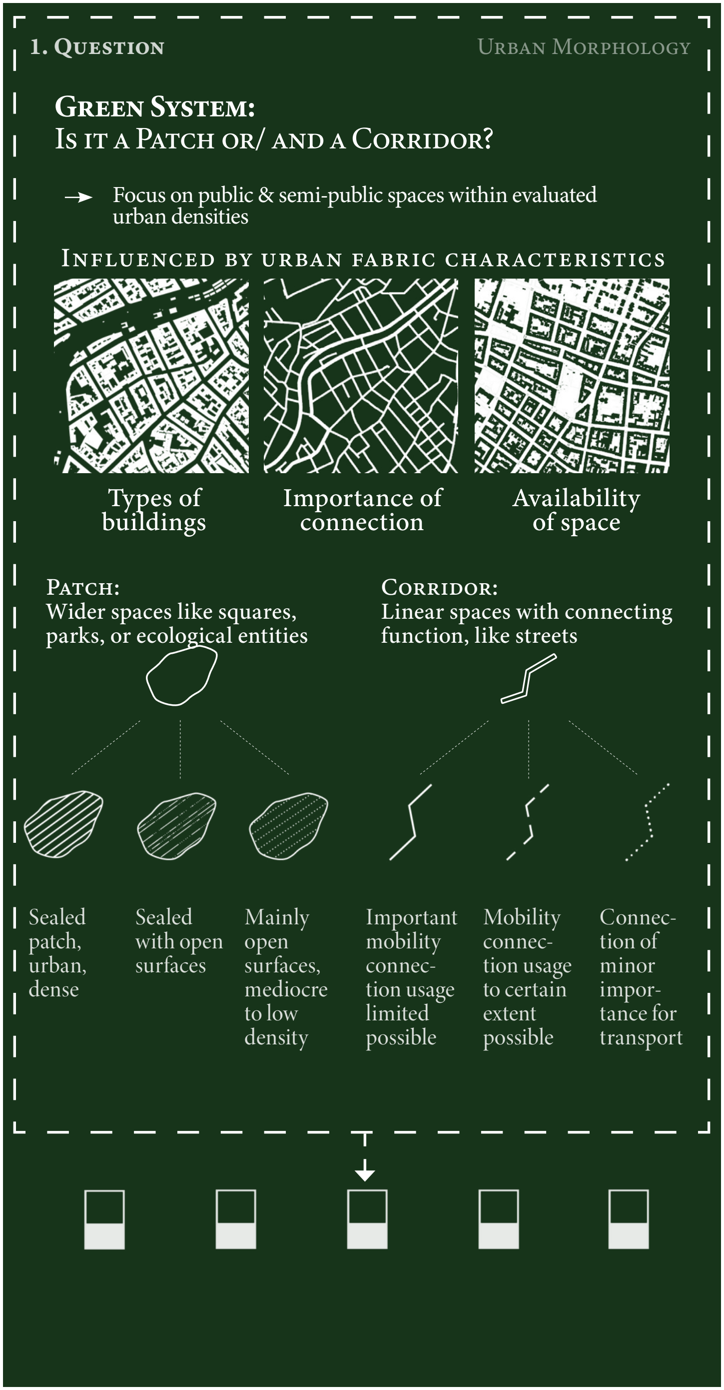
#### Residents

Local involvement from underserved communities or gardening initiatives with limited green space.

Prerequisite:
- public management plan

## Spatial systematization of Vienna

To ensure transferability, but also connectivity of green spaces, natural water cycle management and communal value of interventions, the input navigates through three layers, requesting different urban, landscape & social characterisitcs.

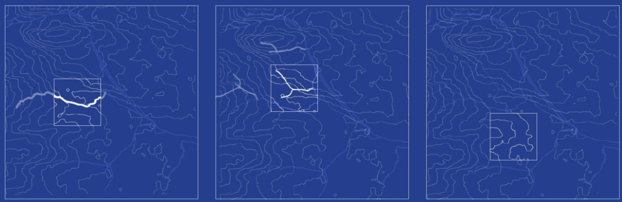


## 2. Question — Landscape Morphology

### Blue System: What is the hydro-geological type?

→ Focus on evaluated hydro-geological types

**Influenced by landscape characterisitcs**



Topography | Soil | Hydrology

**Accumulation:** Accumulation of water due to flat topography and urban layout

- Historical stream with related soil conditions
- Teracced gravel & sand soil
- Closed & sealed system

**Run-off:** Water run-off due to slope and fittitng urban layout

- Historical stream with related soil conditions
- Teracced gravel & sand soil
- Closed & sealed system

## 3. Question (fine tuning) — Social Morphology

### Social system: What is the social value?

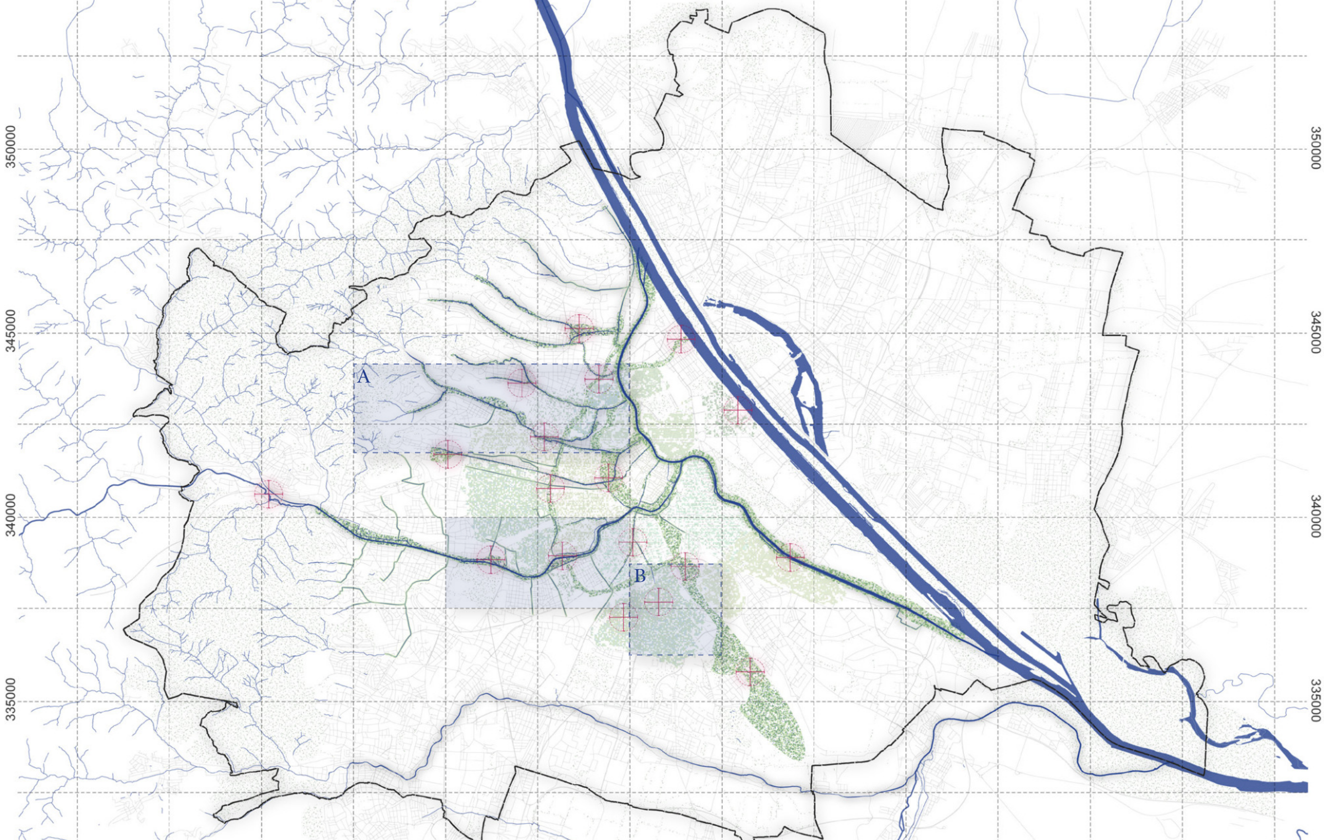
→ Focus on areas with low income and social housing

**Influenced by social characteristics & Justice goal**

Local program | Local needs | Local knowledge

**Social program:** Requirements for the space

- **Educational** Demand for hands-on learning near educational institutions.
- **Productive** Demand for commercial usages like space for delivery
- **Recreational** Demand for recreational usage & leisure
- **Active** Demand for active usages & movement
- **Collective** Demand for communal gatherings, meetings, and collective activities.






# 4.2 Design Exploration

The following design exploration, investigates the integration of natural water cycle management and the provision of connected ecosystems as a communal infrastructure, focusing on the street scale. This approach is aimed at showcasing different urban situations typical of Vienna, characterized by diverse hydromorphological features and urban fabrics, along with their associated potentials and challenges, particularly in low-income areas, addressing environmental justice concerns. The neighbourhoods of Hernals and Favoriten are selected as exemplary focus areas. The integration of the principles (p.125) are explored through sections and mapping, enabling a layered approach and showcasing benefits across different systems.

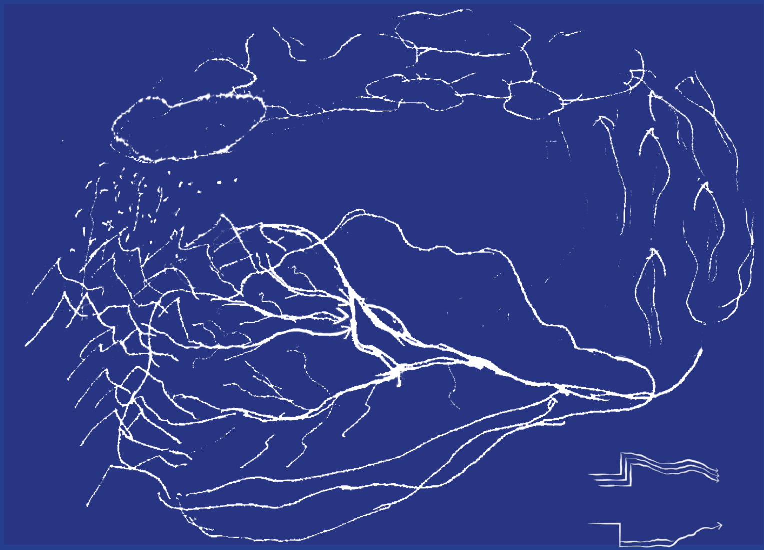
### a | Hernals

Hernals is chosen due to its low-income status and the presence of an existing, yet canalized stream (Als). It also exhibits significant disparities in green space provision, along with limited environmentally friendly transportation options. The area features a heterogeneous urban fabric, predominantly influenced by Gründerzeit architecture, representing a historically typical district in Vienna.

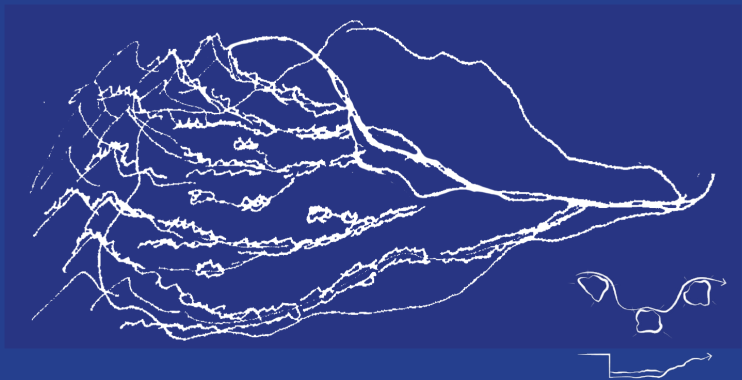
### b | Favoriten

Favoriten is selected based on its contrasting hydromorphological characteristics, absence of a stream landscape, and socio-economic vulnerabilities, including low-income demographics, high migration rates, and a notable lack of green spaces in a densely populated setting. The presence of a pedestrian zone as part of the central public space presents distinct challenges and opportunities, unique to Vienna's urban context.

Natural water cycle management



Provision of connected Ecosystems



Ecosystem as communal inrastructure

## 4.2.1 Profile: Hernals

Hernals, Vienna's 17th district, emerged in 1892 from the fusion of the independent municipalities of Hernals, Dornbach, and Neuwaldegg, housing approximately 56,000 residents. The district is appreciated by its inhabitants for its proximity to both the city centre (west) and recreational areas (east).

In terms of its social and urban structure, the district is a typical Viennese district: the average age is 42, the unemployment rate is 10.1%, the population is growing and the average net income in the district is slightly below the city average (Land Wien 2023). However, notable spatial disparities exist within the district, characterized by differences between its eastern and western areas.

While the eastern precincts, near the city centre, accommodate around three-quarters of the district's population in just one-sixth of its area, boasting Gründerzeit architecture and dense population, the western part (Dornbach, Neuwaldegg, Heuberg) features villa districts, old village cores, and communal housing estates in tranquil green surroundings.

Characteristic for Hernals is a strong demographic mix, reflected in the diverse fabric of its neighbourhoods. The building area of Hernals covers 36% (also citywide) of the district area. Green spaces cover 53% of the district area. However, 91% of the green space consists of forests, meadows, and agricultural land, mainly located in the western part of the district. Public parks and recreational areas constitute a mere 4.4%, highlighting the shortage of green amenities, particularly evident in the eastern precincts of Hernals (Figure 90) (Stadt Wien 2023).

The west-east disparity, mirrored in income differences, resulted in conducting the design exploration on the eastern part of Hernals, spanning from the Alszeile and Leopold-Kunschak-Platz to the end of the Jörgerstraße and encompasses Kalvarienberggasse, Hernalser Hauptstraße and Pezzlgasse. This area is particularly vulnerable to climate extremes, demanding the integration of green infrastructure.

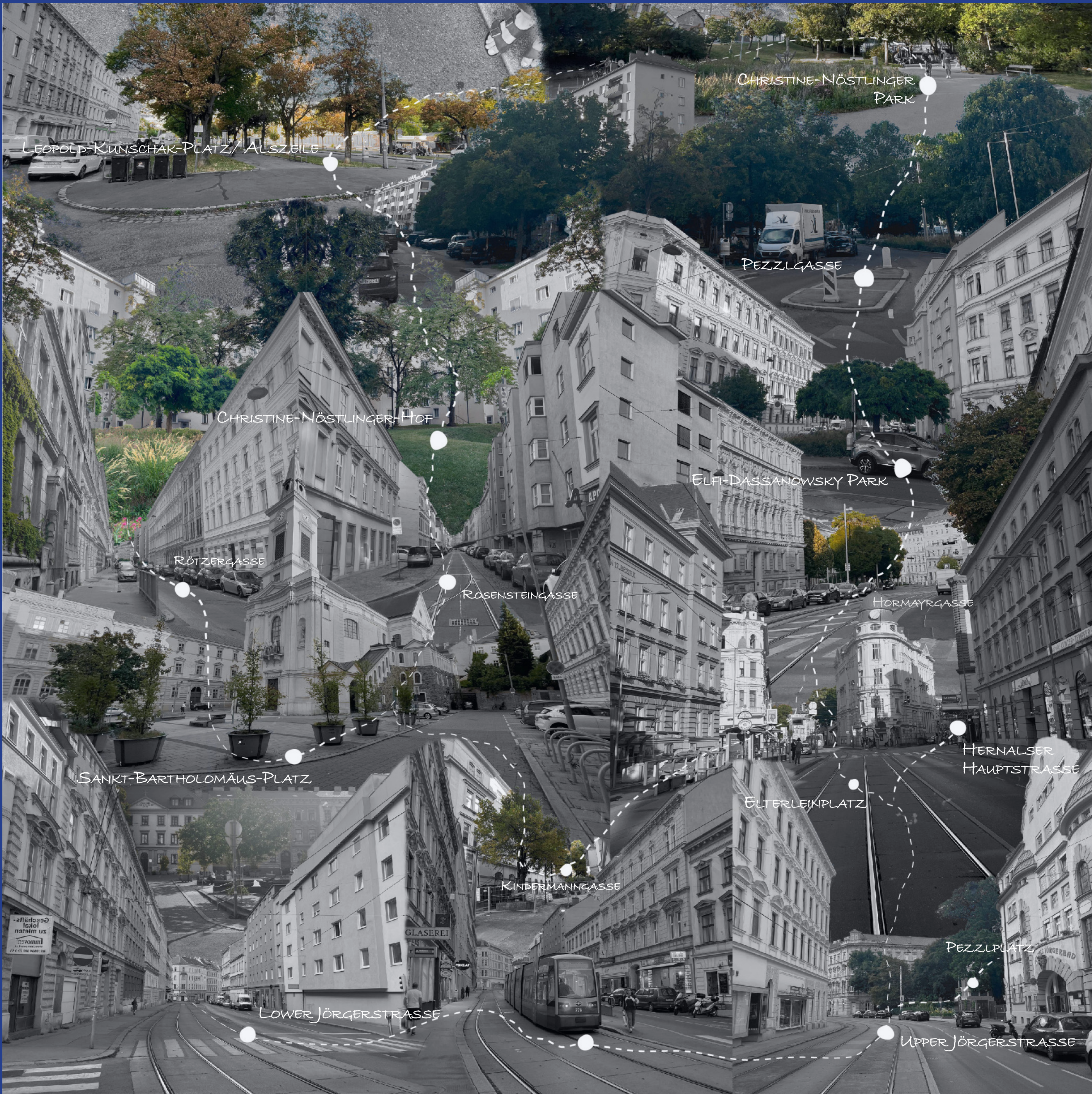
The district's main traffic axis is Hernalser Hauptstraße, tracing its origin to a Roman traffic route, extending towards the Wienerwald. Together with other streets along the course of the Alserbach (Jörgerstraße, Dornbacher- and Neuwaldegger Straße and Alszeile west of Vollbadgasse), it forms the main traffic and historical development axis of the district. Between the Gürtel and the sports club stadium, it also fulfils the function of the most important commercial street in the district, notably Elterleinplatz in conjunction with Jörgerstraße. Subsequently, Kalvarienberggasse, intersecting Hernalser Hauptstraße at Elterleinplatz, is significant in Hernals' commercial landscape.

Predominantly, commuter traffic from the western precincts utilizes the Hernalser Hauptstraße. Given the 17th district's relatively sparse network of cycling infrastructure, there is an acute need to establish alternative cycling connections (Stadt Wien 2023).



**Notes:**

Right page [Fig 90]: The documentation of Hernals reveals both its spatial attributes and deficiencies. This collection of urban elements, which delineate local contexts (Rowe 1978), highlights an absence of qualitative green systems within a predominantly built and sealed environment. The impressions were collected during a walking tour conducted as part of my field trip in Vienna.


Christine-Nöstlinger Park
Leopold-Kunschak-Platz/ Alszeile
Pezzlgasse
Christine-Nöstlinger-Hof
Elfi-Dassanowsky Park
Rötzergasse
Rosensteingasse
Hormayrgasse
Hernalser Hauptstrasse
Sankt-Bartholomäus-Platz
Elterleinplatz
Kindermanngasse
Pezzlplatz
Lower Jörgerstrasse
Upper Jörgerstrasse

## Hernals: The Green System

### Analysis

The Wienerwald serves as a core biotop in the west, while the area along the Danube canal and the Danube are important biotopes in the east. Despite plans to connect these ecosystems, implementation has been insufficient thus far.

The building density increases from west to east, resulting in a high amount of sealed surfaces and limited availability of green space, especially in the east of Ottakring (16th district), Hernals (17th), or Währing (18th). The existing smaller green parks & squares in Hernals are isolated, leaving the potential for connecting these to increase green spaces and create a network of ecosystems.

In Hernals, the western areas are inadequately connected via public transport and bike routes, leading to heavy commuter traffic from wealthier areas towards central Vienna towards the Hernalser Hauptstraße & Jörgerstraße.


Legend

- Forest
- Meadow
- Graveyard green
- Green area
- Potential public green area
- Public green area (park)
- Public area with greenefying potential (square)
- Spatial delimiters
- Courtyards with potential
- Planned green corridors/ networks
- Trees with crown size
- Gravel banks
- Auer floors (Floodplain soils)
- Topography
- District borders
- Building density (GSI 0,9-0,15)
- Public transport: Train, Metro, Tram, Bus
- Public transport station
- Primary, secondary & primary roads
- 30 km/h-zones



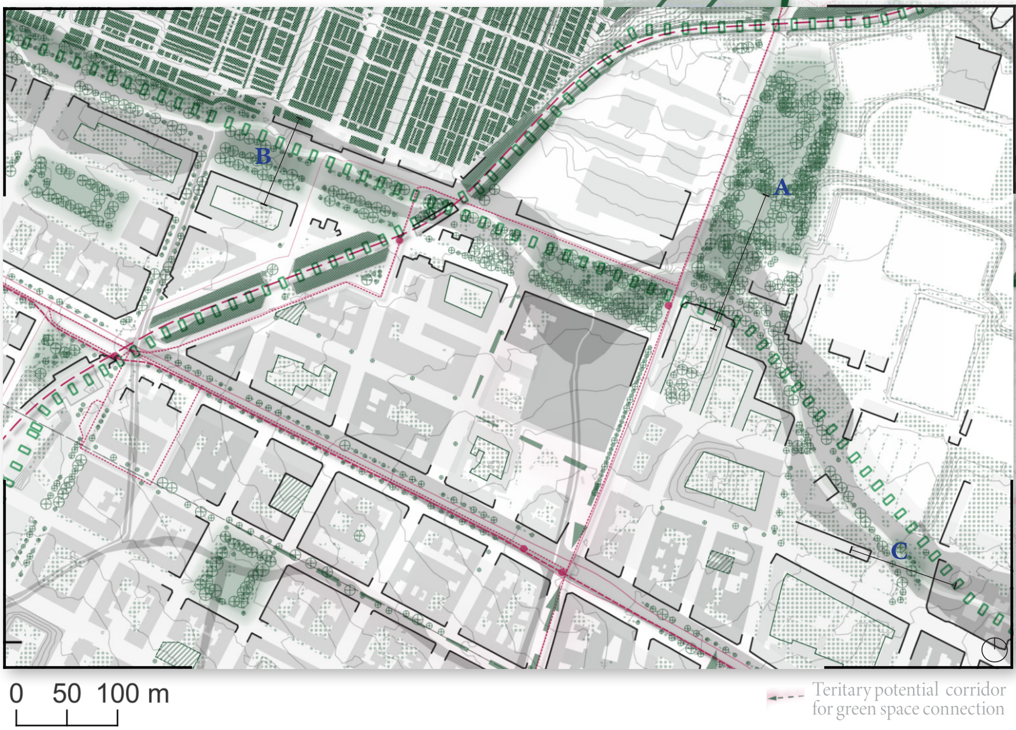


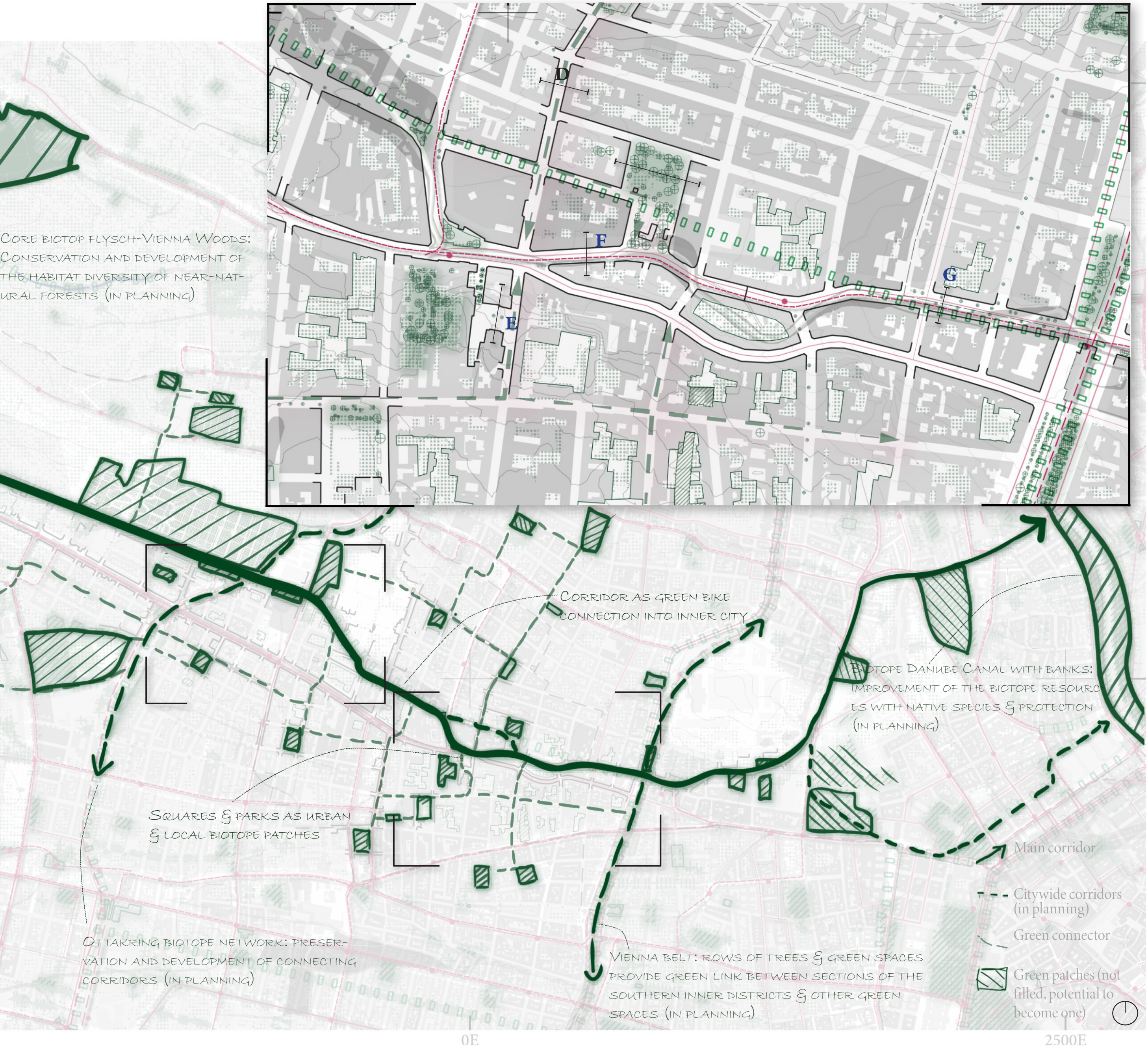

[Fig. 91]: Analysis green system Hernals

# Hernals: The Green System

## Principles

- Streamscape as main green corridor in ecosystem network
- Green corridor connecting core ecosystem patches
- Ecosystem patches as nodes in a network connected towards main corridor
- Fostering eco-mobilities with ecosystem benefits & reducing parking space
- Car-poor supergrätzel with shared streets & temporary/ collective parking




[Fig.92-94]: Micro analysis and concept green system Hernals

# Hernals: The Blue System

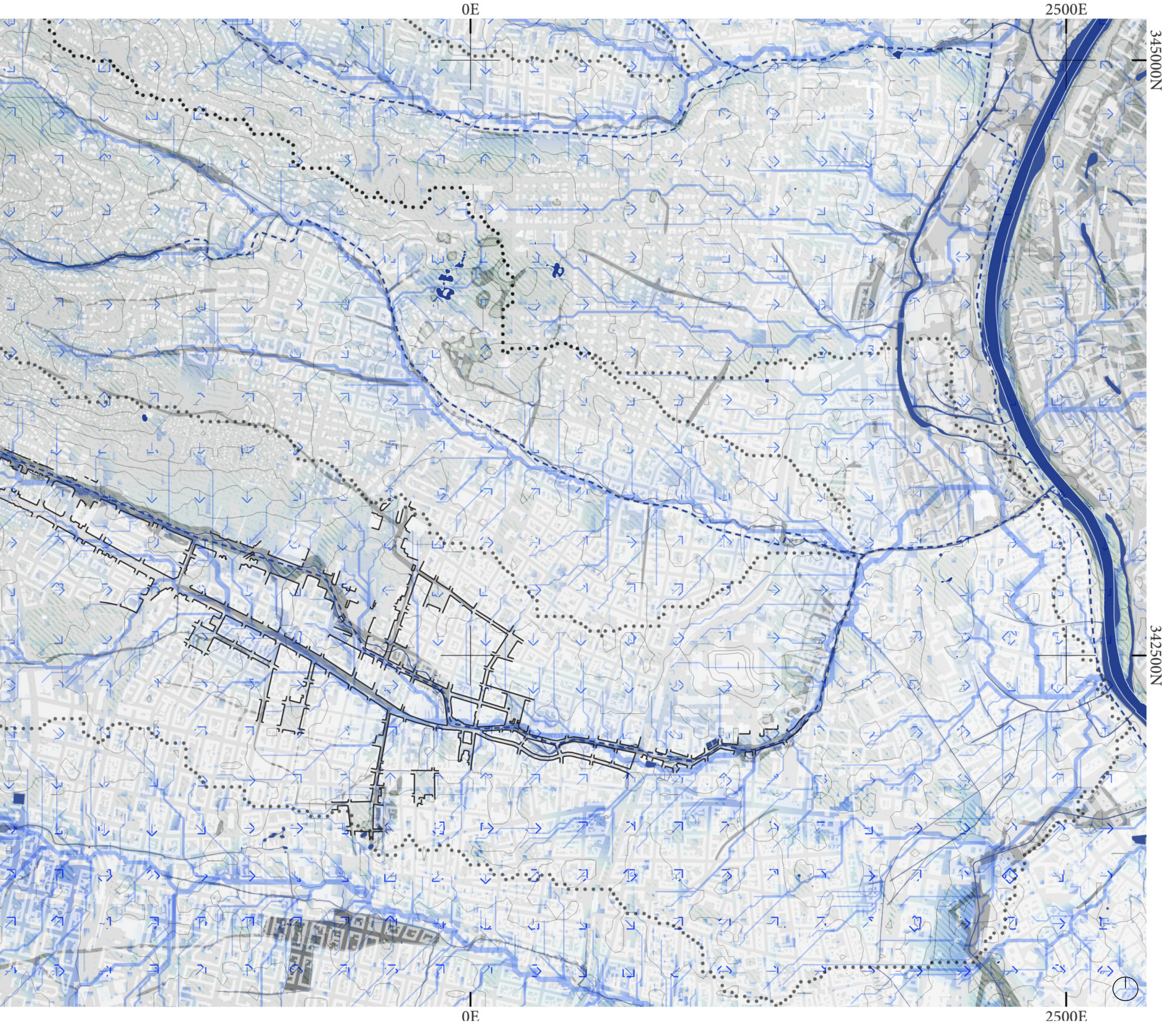
## Analysis

Due to the landscape morphology, streams have historically meandered through Vienna, playing a significant role in shaping the city's landscape and urban layout. These streams, originating from the Wienerwald, flow over moderately productive groundwater found in platy, loamy, and less permeable sandstone gravels (WGM 2019). This geological composition makes them ideal for diverting rain and stream water, as they naturally accumulate water and have slow infiltration rates. Urban development led to the canalization of these streams, with many now flowing underground, occasionally supporting wastewater flow, as seen with the Als in Hernals. Leveraging these former streams for stream and rainwater drainage into the Danube and to supply green corridors is essential for natural water cycle management in the city. Multifunctionally incorporating wider spaces in the urban layout allows for the integration of water retention/detention areas, effectively slowing down rain and stream water runoff and enabling collection and storage for dry periods. Wienerwald streams and rivers, such as the Wienfluss, along with favourable topography, are also present in many other districts of Vienna (16th, 18th, etc.), presenting opportunities to enhance Vienna's climate resilience.



Legend

- Vienna canal/ streams
- Canalized streams
- Run-off floating direction
- Run-off floating patches
- Topography
- Catchment areas
- Catchment areas
- Course & accumulation of water based on topography & distribution
- Historic course of stream (1630)
- Gravel banks
- Auer floors (Floodplain soils)
- Green areas

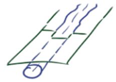



[Fig.95]: Analysis blue system Hernals

# Hernals: The Blue System

## Principles

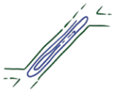
- Utilization of rain & stream water via daylighting of stream



- Streamscape to guide and drain stream/ rainwater with distributing canals

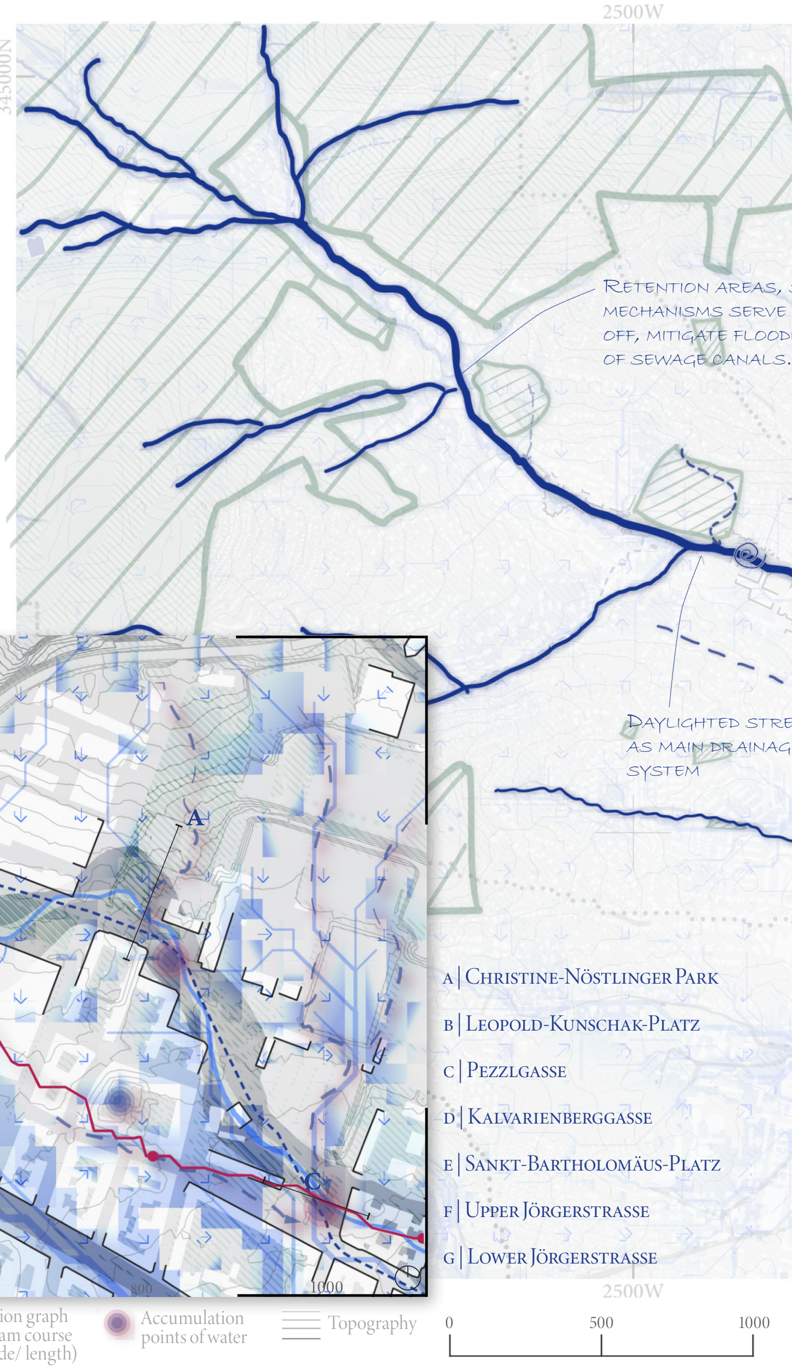
- Patches (squares & parks) are used to store and infiltrate water

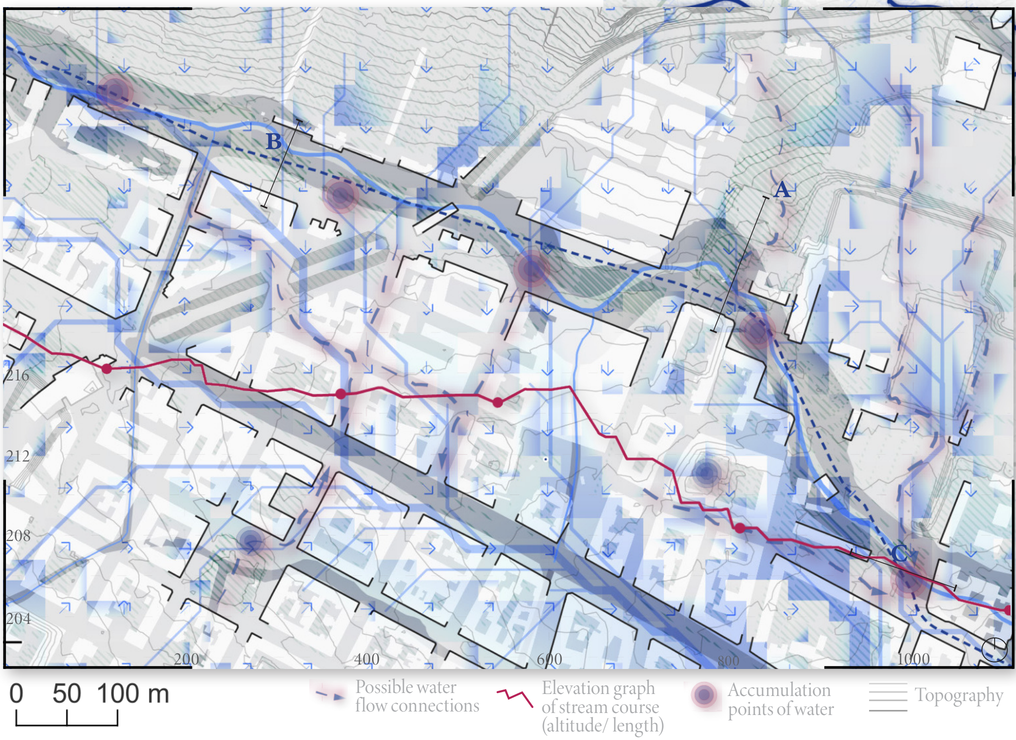
- Streets as water storage/ infiltration areas, when topography allows accumulation of water

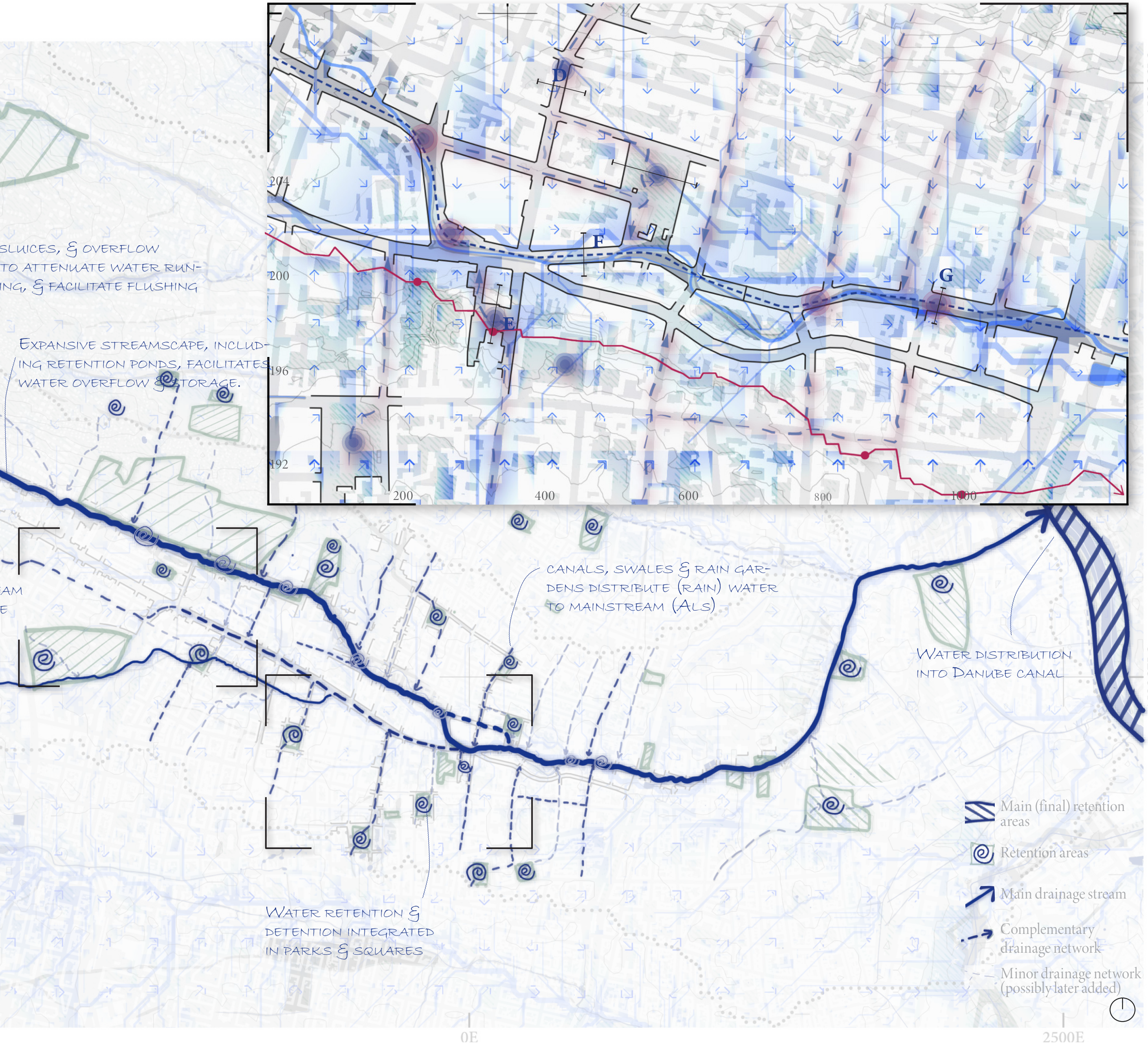


- Canals, swales & rain gardens distribute (rain) water to stream








[Fig. 96-98]: Micro analysis and concept blue system Hernals

## Hernals: The Social System

### Analysis

The western part of Hernals lacks sufficient connections via public or eco-friendly transportation options. Conversely, in the east, the potential green-blue corridor aligns with tram railways, creating a demand for eco-friendly alternatives in the west and offering the potential to synchronize eco-friendly mobility with ecosystem benefits.

This potential route passes various educational facilities and social housing areas. Integrating the green-blue network with these institutions can yield numerous social benefits for users, including students and residents, while also strengthening social infrastructure.

Linking social institutions to the green-blue mobility corridor establishes a network that provides social amenities tailored to local needs, thereby upgrading areas along Hernals and increasing accessability to the ecosystem. While the section from Viennaforest to Elterleinplatz is predominantly residential and educational, the stretch from Elterleinplatz to the Vienna Gürtel is characterized by commercial use. However, the Jörgstraße area features several vacant ground-floor spaces. Integrating a green-blue corridor here has the potential to rejuvenate the area and foster vibrancy.



Legend

- Social housing (high to low amount of flats)
- Public social facilities
- Commercial facilities with public functions
- Public/ private administration
- Public/ private transport facilities
- Public park/ square
- Green areas
- Train/ Metro
- Tram
- Bus

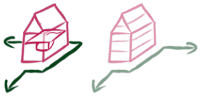

[Fig. 99]: Analysis social system Hernals

# Hernals: The Social System

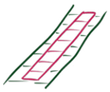
## Principles

- Aligning eco-mobility routes with ecosystem benefits

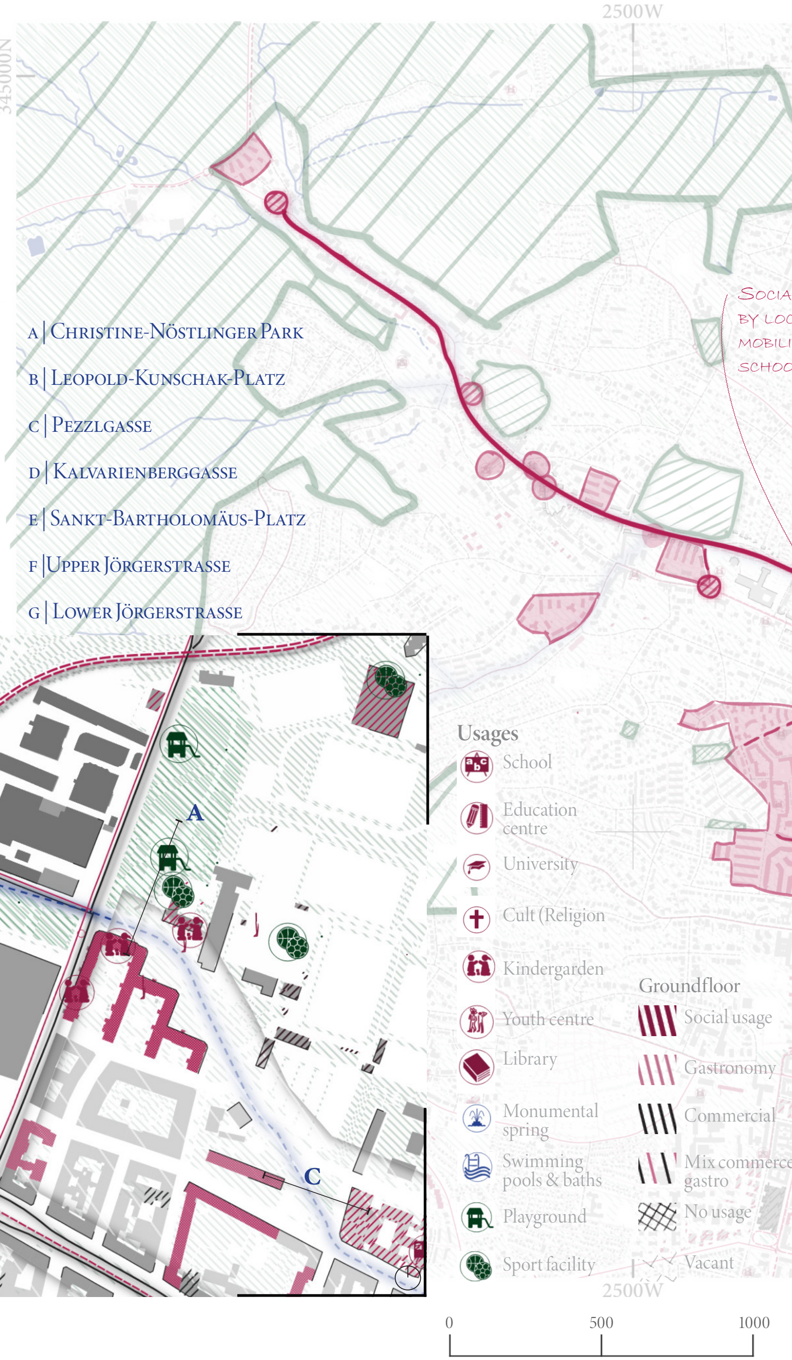
- Prioritization & connection of educational facilities

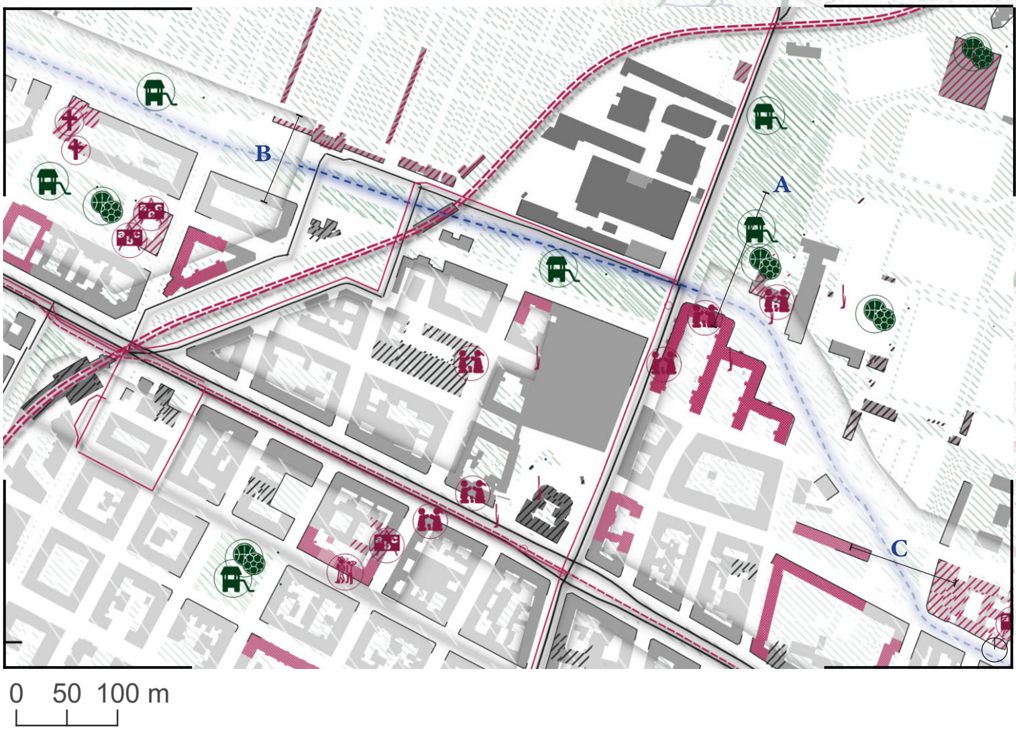


- Ecosystem as social infrastructure



- Fostering ecosystem stewardship




[Fig. 100-102]: Micro analysis and concept social system Hernals

# Green-blue-social corridor for Hernals

## Conclusion

Systemic focus

The design concept outlines a green-blue-social corridor featuring interconnected green spaces (patches), drainage canals/swales, and social amenities, particularly educational facilities. Within this corridor and network, systemic focus areas are identified. In addition to establishing seamless bicycle connections and integrating mobility stations, there is a strong emphasis on providing activities for children and young people near educational facilities, as well as creating recreational and communal spaces around social housing areas.

In locations already proximate to natural surroundings and less densely urbanized, the focus shifts towards nature-oriented design, incorporating areas for wild vegetation and promoting ecosystem values. This includes allocating space for flooding within the green-blue infrastructure and establishing natural riparian areas.

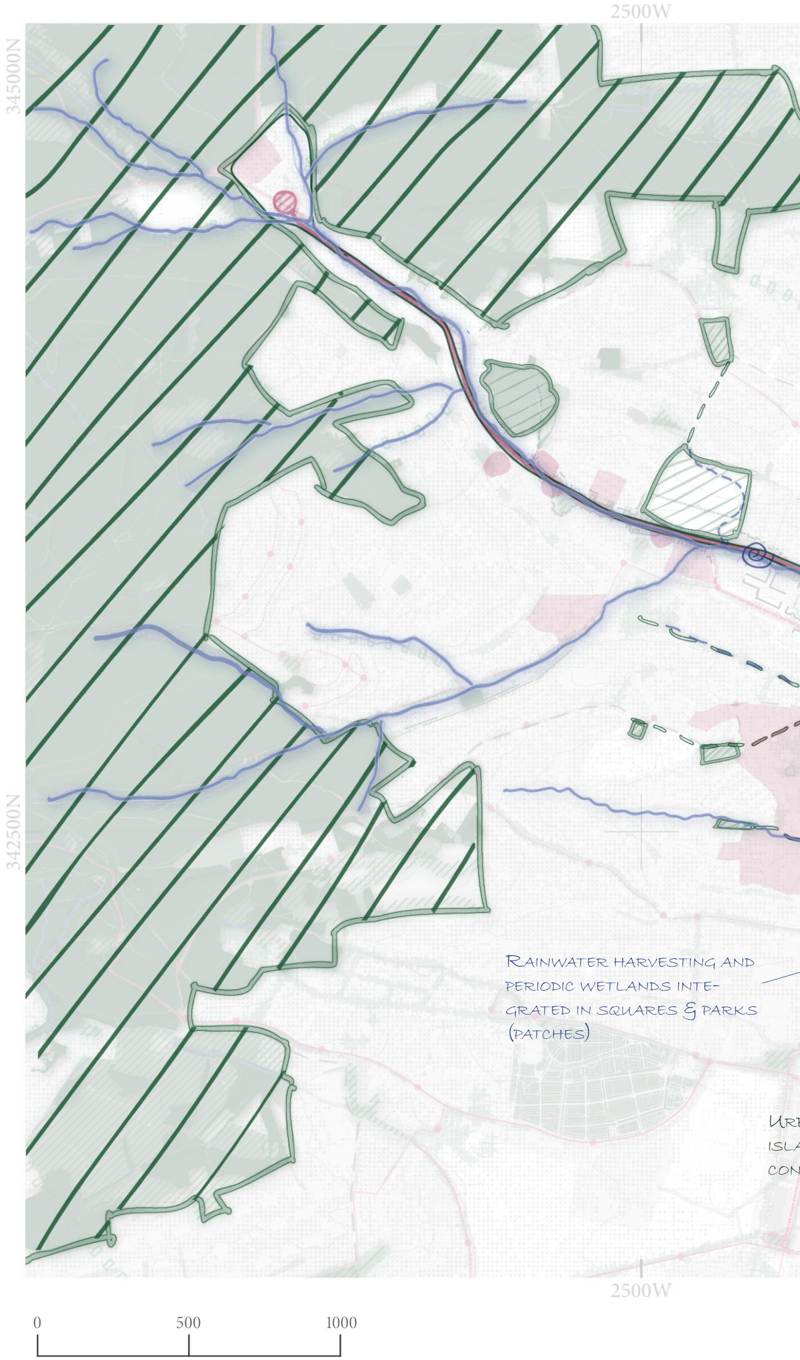
In more densely urbanized spaces towards the east, the priority is to maintain or provide adequate space for social activities and residents within the (urban) ecosystem, with varied focal points or minimum benefits for each system. Ensuring proper drainage and storage of rainwater within the urban space is essential, with specific areas of focus influenced by the potential to connect green spaces (patches) and social infrastructure to the main corridor. This often results in overlapping systemic values, but also results in purely social, green, green-social, green-blue, or purely blue connections.

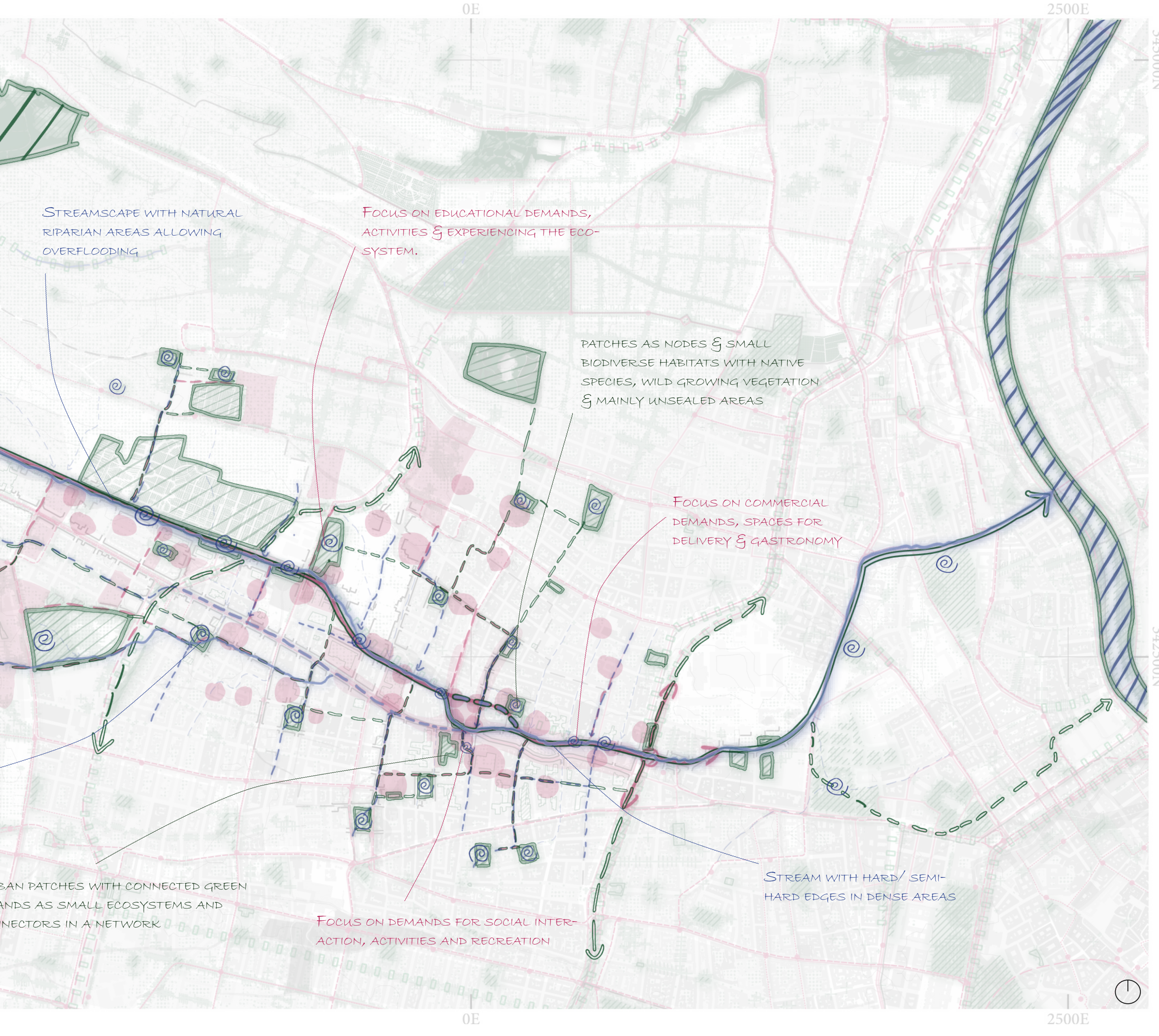
In the further design exploration, the integration of this natwork and their benefit are investigated.



Legend

- Green corridor
- Planned ecosystem corridors
- Green connector
- Fostering/ preserving ecosystem benefits
- Main drainage stream
- Complementary drainage network
- Retention/ detention areas
- Drainage network of swales/ canals
- Mobility corridor with social benefits
- Mobility stations/ connection points
- Social benefits focus
- Educational/ active focus
- Recreational/ communal focus
- Productive & gastro focus






[Fig.103]: Conclusive concept Hernals

## Layered design exploration via sections

In the further design exploration, the integration of the green-blue-social network into the urban context is investigated through sections. Using these as the primary method allows for consideration of subsoil characteristics, a human perspective at the street scale, and a layered approach across different systems: green, blue, and social.

Initially, each focus area undergoes detailed analysis, assessing its current state, urban and landscape characteristics, as well as social demands. These analyses incorporate findings from mapping and microstories to comprehensively capture the area.

Subsequent sectional examinations depict the area in a transitioned and idealized climate-resilient scenario, with earlier defined principles integrated into the urban context. Additionally, the benefits and characteristics within the blue and social systems are clearly showcased, making values easily understandable.

# The Present

## LAYERED SYSTEMATIZATION

Focus area is analysed thoughout different layers, evaluating urban & landscape types, as well as social characteristics and demands. Systematization and idendification of focal areas & systems.

Systemized (spatial) type

Location of section

Focal system


## CURRENT LAYOUT SECTION

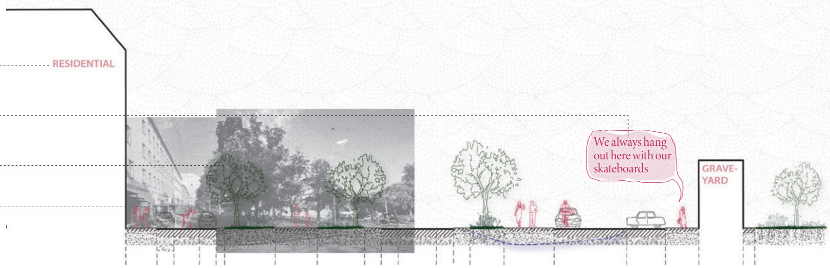
Present state of design area is displayed with soil characterisitcs, current usage, spatial layout/measurements, and feedback from local users, illustrating local demands & knowledge at the street scale comprehensibly.

Usage adjacent buildings

Impression local user (interview)

Impression field trip

Local users




# The Green System

Displaying finalized & ideal transition of urban landscape towards ecosystem integrated and climate resilient environment in street scale.

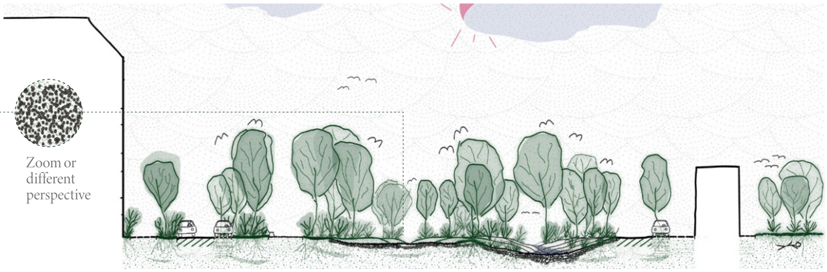
Main principle

Principle

Intervention

Explanation/ implementation

Zoom or different perspective



# The Blue System

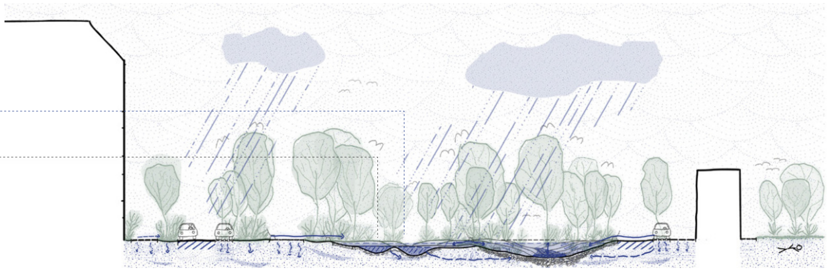
Displaying water system related principles and its value and character in transitioned urban landscape. Showcasing potential state within rain intense periods.

Main principle

Principle

Intervention

Change of use & water characteristics in different weather conditions



# The Social System

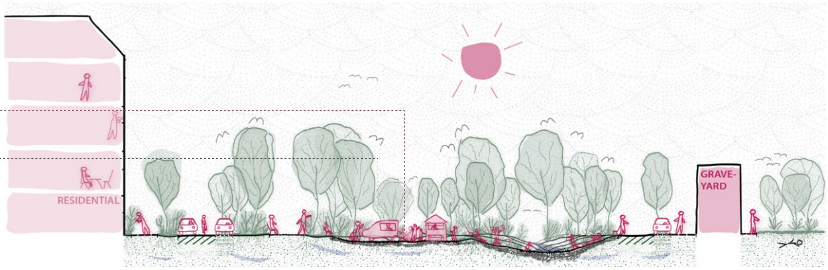
Displaying social system related principles and social benefits and character in transitioned urban landscape. Showcasing potential usages.

Main principle

Principle

Intervention

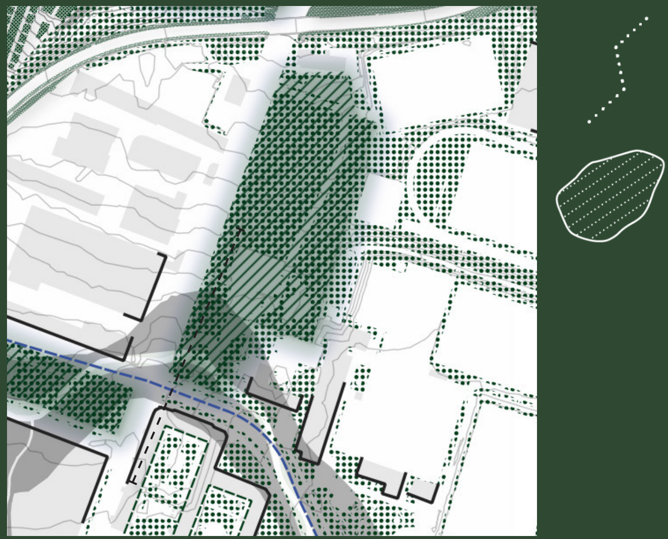
Social usage & benefit



# A | Christine-Nöstlinger Park

An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, displaying demands and focal systems.

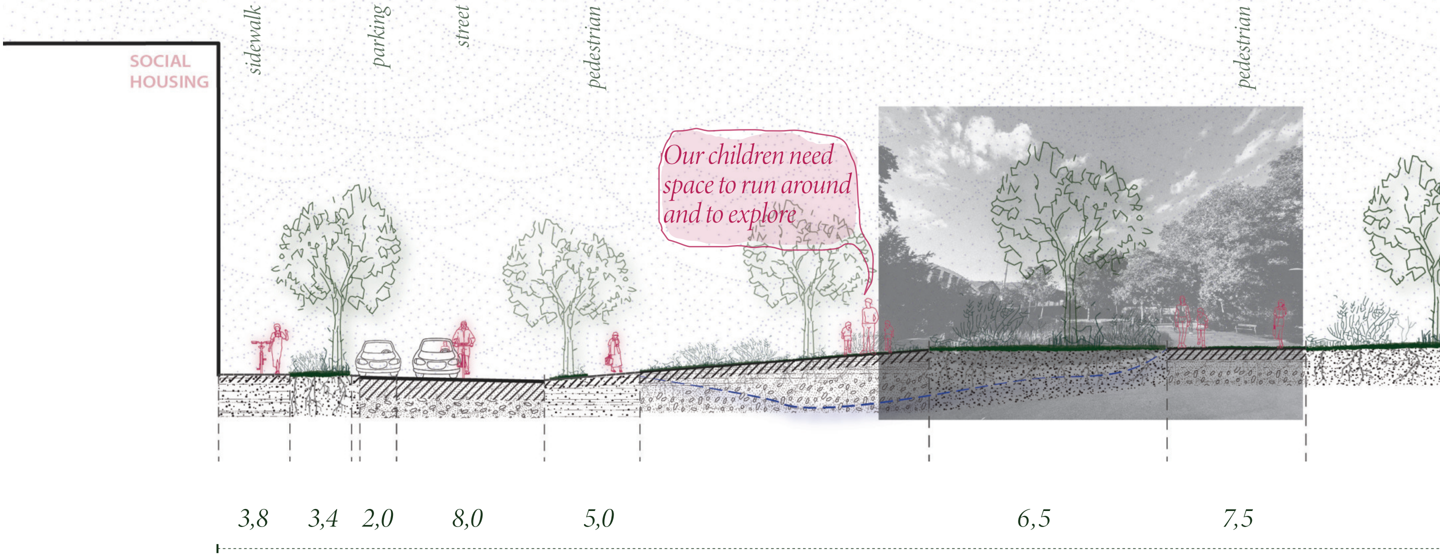
Subsequent pages illustrate the integrated principles within the transitioned & aspired climate-resilient urban landscape and showcase water characteristics and social benefits.

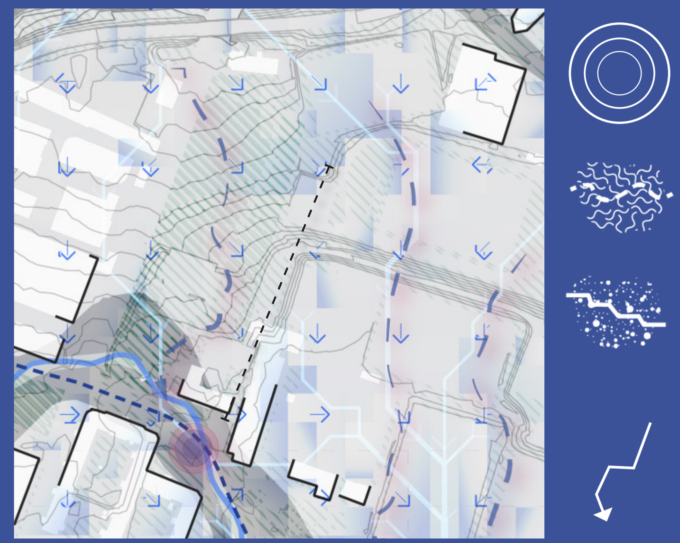


- spacious green park (patch)
- no important mobility connection
- potential & planned important green connection (corridor)

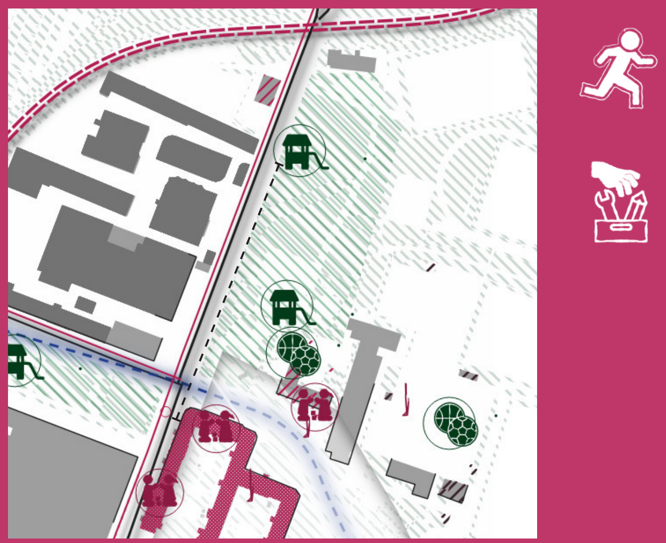


## The Present

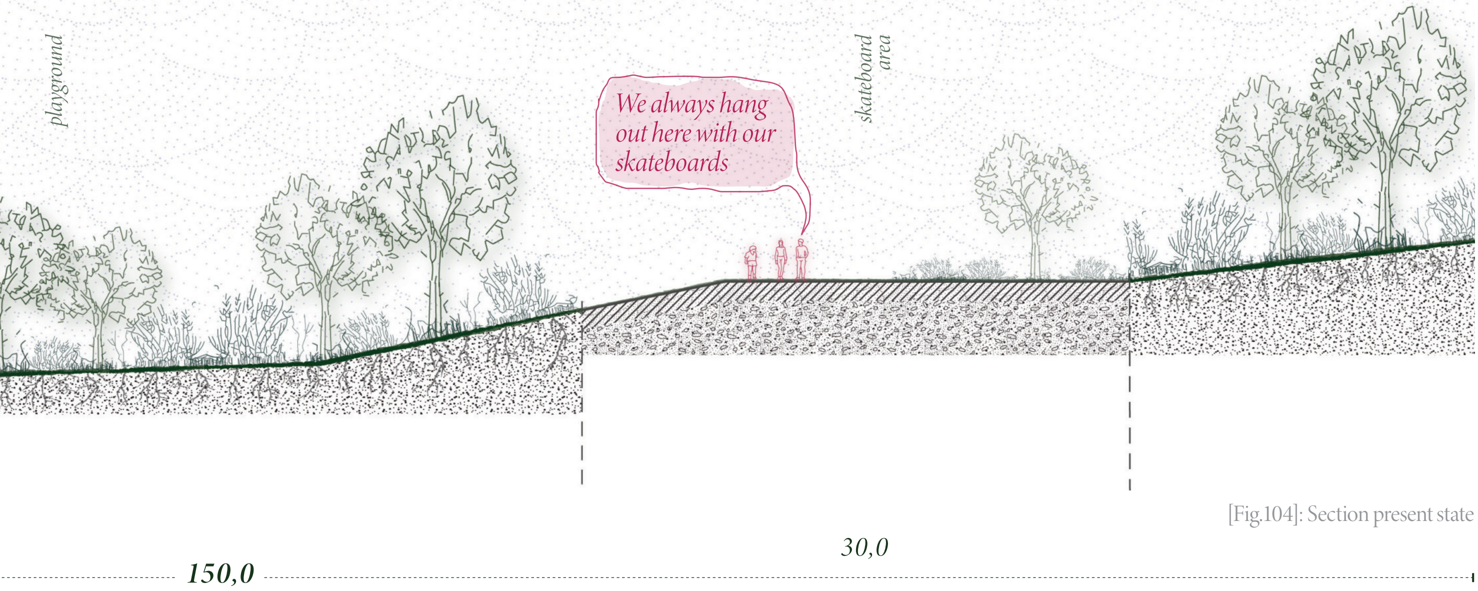




- terraced slope
- historical stream bed
- natural water run-off
- accumulation of water



- kindergarden (3)
- playground
- sport area
- social housing




[Fig.104]: Section present state

## A | Christine-Nöstlinger Park

**Systemic focus**

**Timeframe**

### Shared communal space

Shared space & parking space reduction

Reduce space for individual transport & private usage of public space

30 km/ h zones are shared-space zones, reducing and slowing down individual motorized transport

### Breathing surface

Stop sealing surface!

Construction stop of paved/ sealed surfaces & reducing paved areas where possible

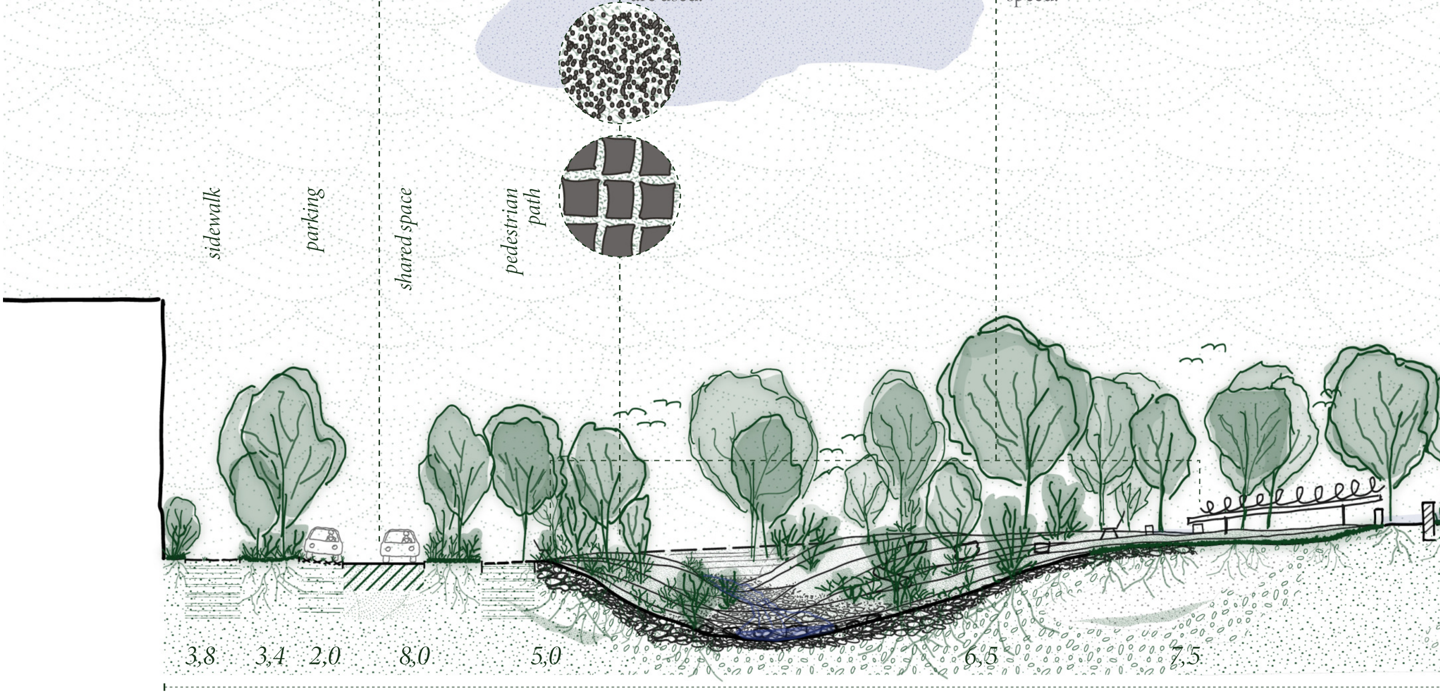
The principle emphasizes preserving natural surfaces, exploring permeable coverings and/ or water storage feasibility for sealed surfaces. Traditional parking areas are transformed using grass pavers for enhanced functionality and environmental impact.
For sidewalk tiles and other permeable surfaces are used.

### Green corridor

Natural stream landscape as green corridor

Space for waterstream landscape with green shores as green corridor to foster biodiversity

Excavate old stream beds based on urban spatial constraints, creating a flat surface for natural water flow (allows water to follow own streaming route). The nutrient-rich valley floors, enriched by clay in sediments, support diverse flora and fauna. Use of poles to stabilize sedimentation, forming gravel islands akin to young deltaic systems, mitigating runoff speed.



## Ecological patches

### Terraced mounted basins

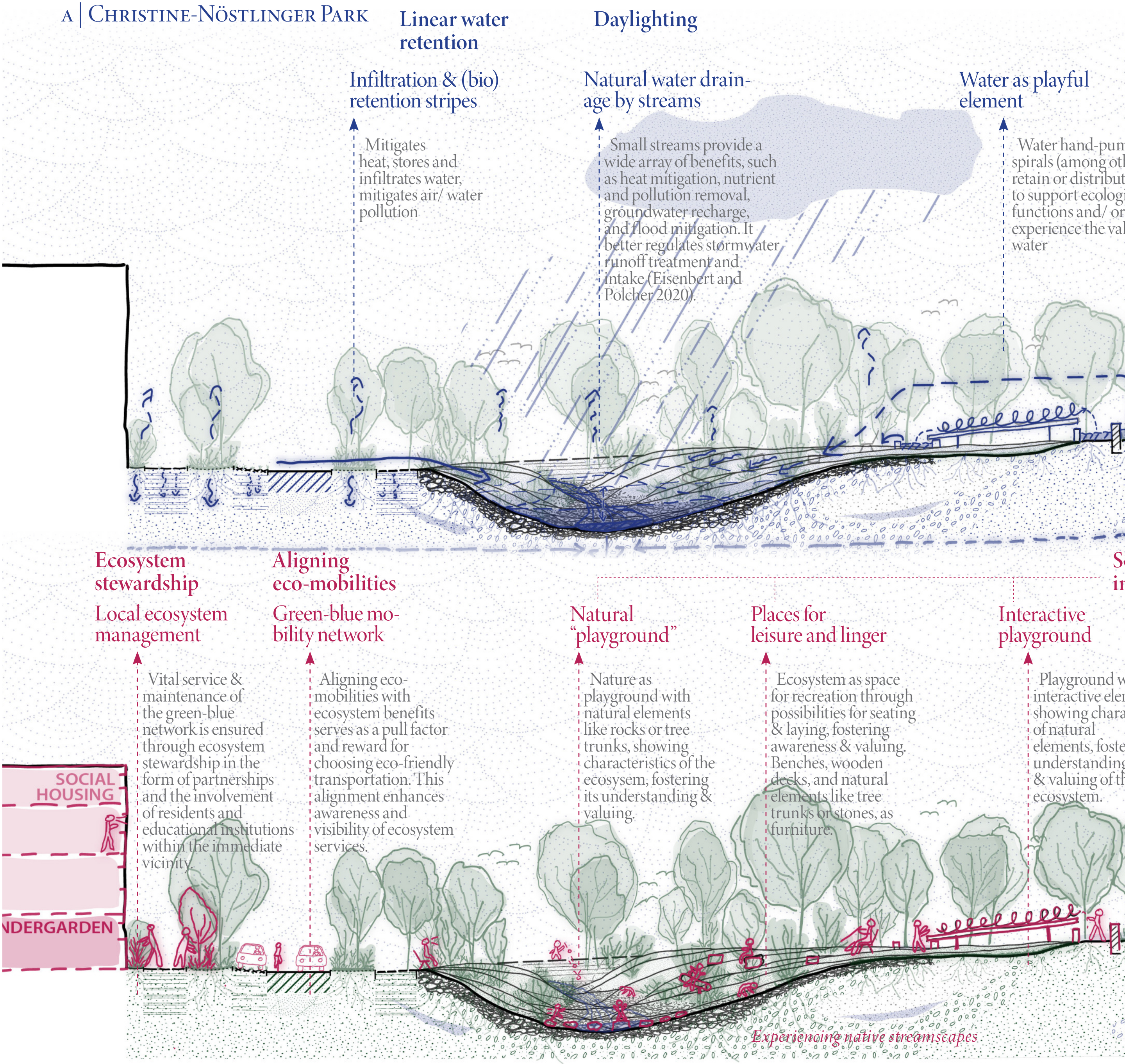
(Vegetated) gabions or stone barriers used for terracing slope to fixate basins/ errosion.

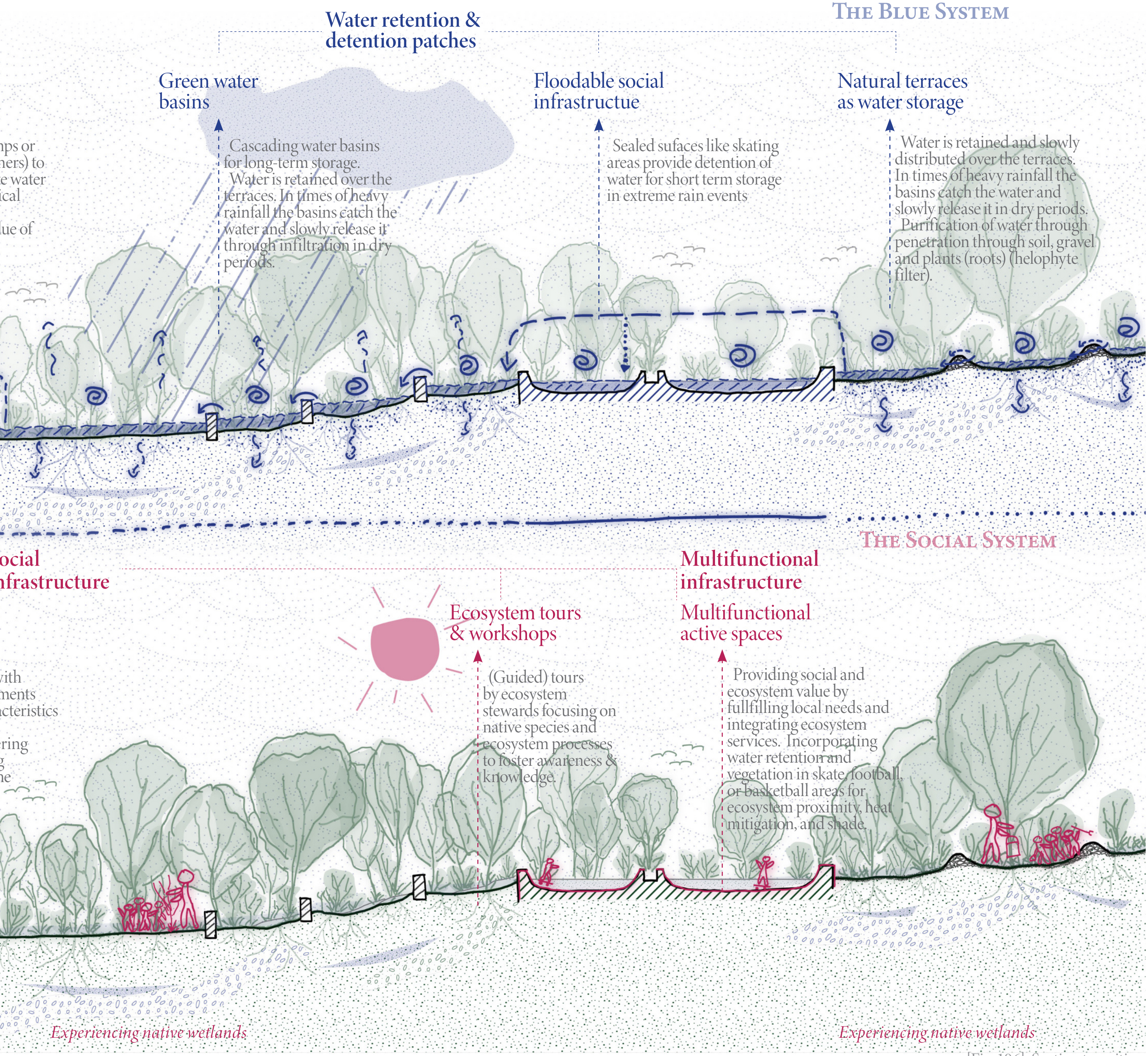
### Terraced living slopes

Terraces through relocation of local soil and stones to form basins (nature-based & long term approach).

Excavate and pile soil to create basins, best situated in sloped areas with a sizable water catchment. Hanging valleys, with moderate slopes, are ideal for water accumulation, partly stabilized by wattle fences (Polster 2008). These consistently moist environments foster a unique biosphere, providing microhabitats for diverse flora and fauna, serving as a freshwater source during dry periods.


[Fig. 105]: Section green transition

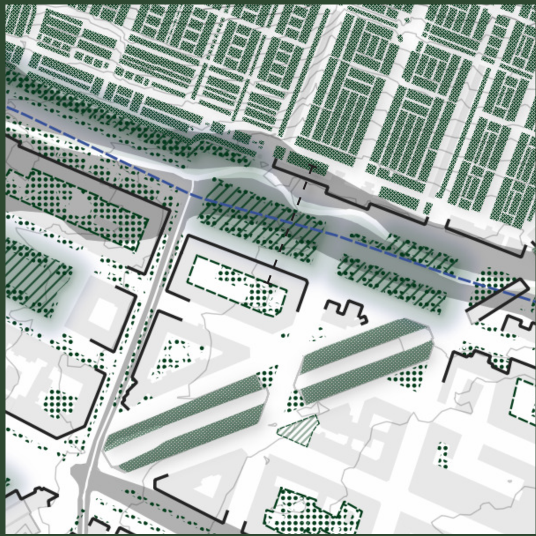

A | Christine-Nöstlinger Park
Linear water retention
Daylighting
Infiltration & (bio) retention stripes
Mitigates heat, stores and infiltrates water, mitigates air/ water pollution
Natural water drainage by streams
Small streams provide a wide array of benefits, such as heat mitigation, nutrient and pollution removal, groundwater recharge, and flood mitigation. It better regulates stormwater runoff treatment and intake (Eisenbert and Polcher 2020).
Water as playful element
Water hand-pum
spirals (among ot
retain or distribut
to support ecolog
functions and/ or
experience the val
water
Ecosystem stewardship
Aligning eco-mobilities
Local ecosystem management
Vital service & maintenance of the green-blue network is ensured through ecosystem stewardship in the form of partnerships and the involvement of residents and educational institutions within the immediate vicinity.
Green-blue mobility network
Aligning eco-mobilities with ecosystem benefits serves as a pull factor and reward for choosing eco-friendly transportation. This alignment enhances awareness and visibility of ecosystem services.
Natural "playground"
Nature as playground with natural elements like rocks or tree trunks, showing characteristics of the ecosysem, fostering its understanding & valuing.
Places for leisure and linger
Ecosystem as space for recreation through possibilities for seating & laying, fostering awareness & valuing. Benches, wooden decks, and natural elements like tree trunks or stones, as furniture.
Interactive playground
Playground w
interactive ele
showing chara
of natural
elements, foste
understanding
& valuing of th
ecosystem.
SOCIAL HOUSING
NDERGARDEN
Experiencing native streamscapes



[Fig. 106]: Section transition

## B | Leopold-Kunschak-Platz

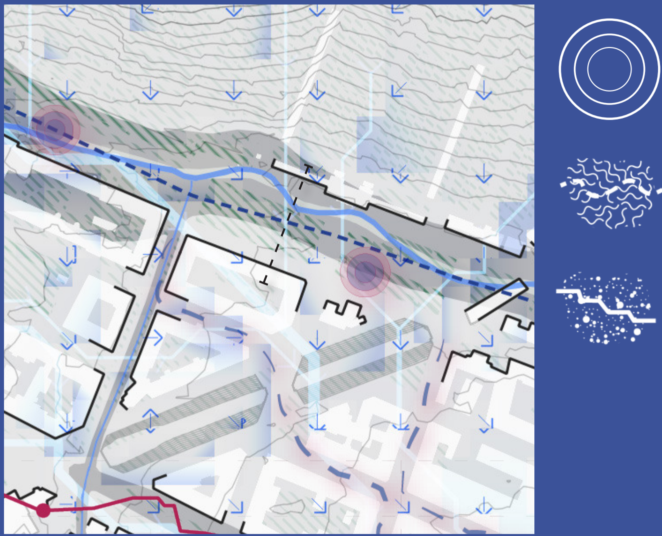
An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, showcasing demands and focal systems.



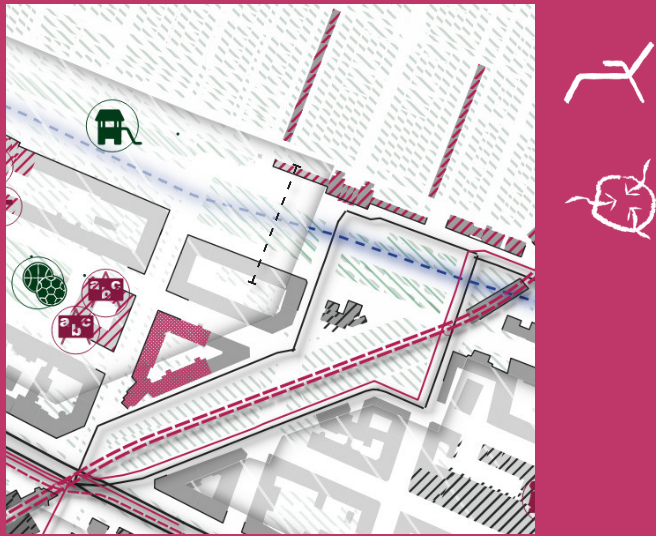
Patch
- fragmented monocultural green surfaces but wide space
- no important mobility connection

CORRIDOR
- potential & planned important green connection (corridor)

The Present
RESIDENTIAL

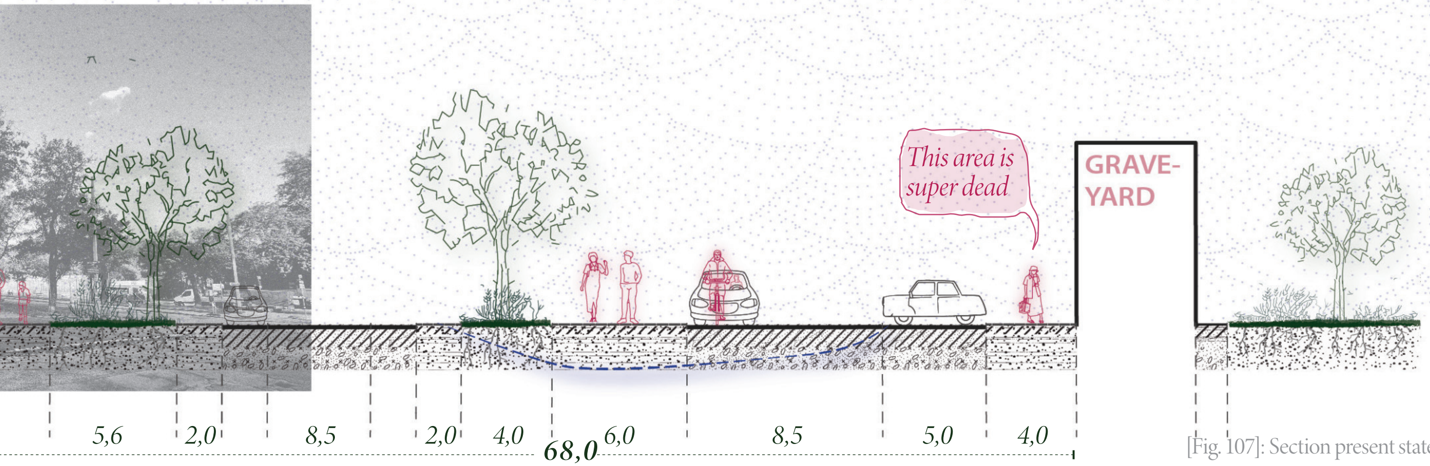


PATCH
- terraced sand and gravel soil
- historical stream bed
- accumulation of water



PATCH
- calm area next to sanitary
- weekly market
- lifeless





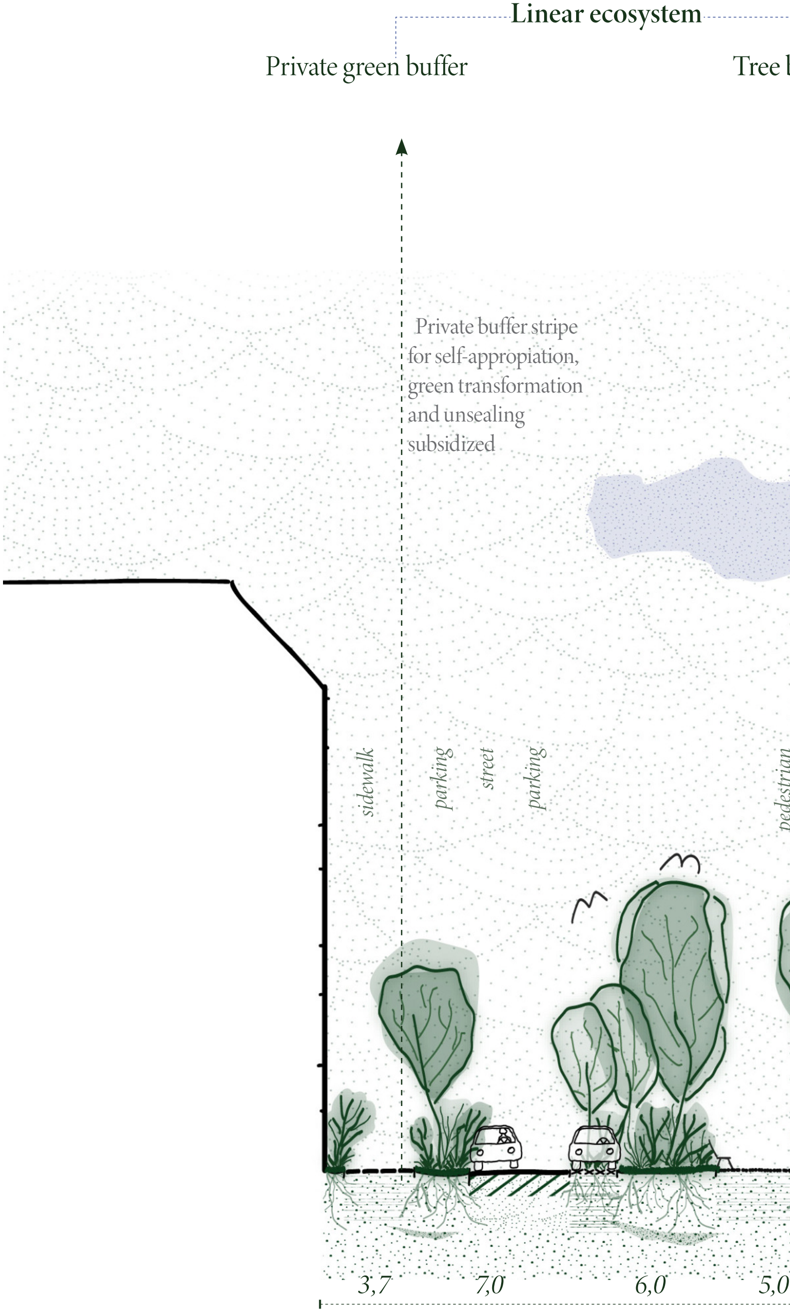

[Fig. 107]: Section present state

## B | Leopold-Kunschak-Platz

Systemic focus

Timeframe

This illustrates the systemic focus & the integrated principles within the transitioned & aspired climate-resilient urban landscape.



## Green corridor

## Shared communal space

### boulevard

Mitigating heat by providing shadow and mitigating habitat & biodiversity loss by providing green connection

Orientation on existing trees/ possibilities -Considered should be the reduced airflow/ wind velocity

### Streamscape buffer zones

Spreading stream bed with space for ponds/ retention in form of buffer zones.

Spreading stream bed with space for ponds/ retention in form of buffer zones. Constructed streamscape and alluvial forests over time become natural habitats giving the stream space to expand into the urban landscape, taking different courses and finding its own path. This will create areas of multi-channeled streams within the streamscape, enriching the diversity of public green spaces (Iwaszuk et al. 2019).

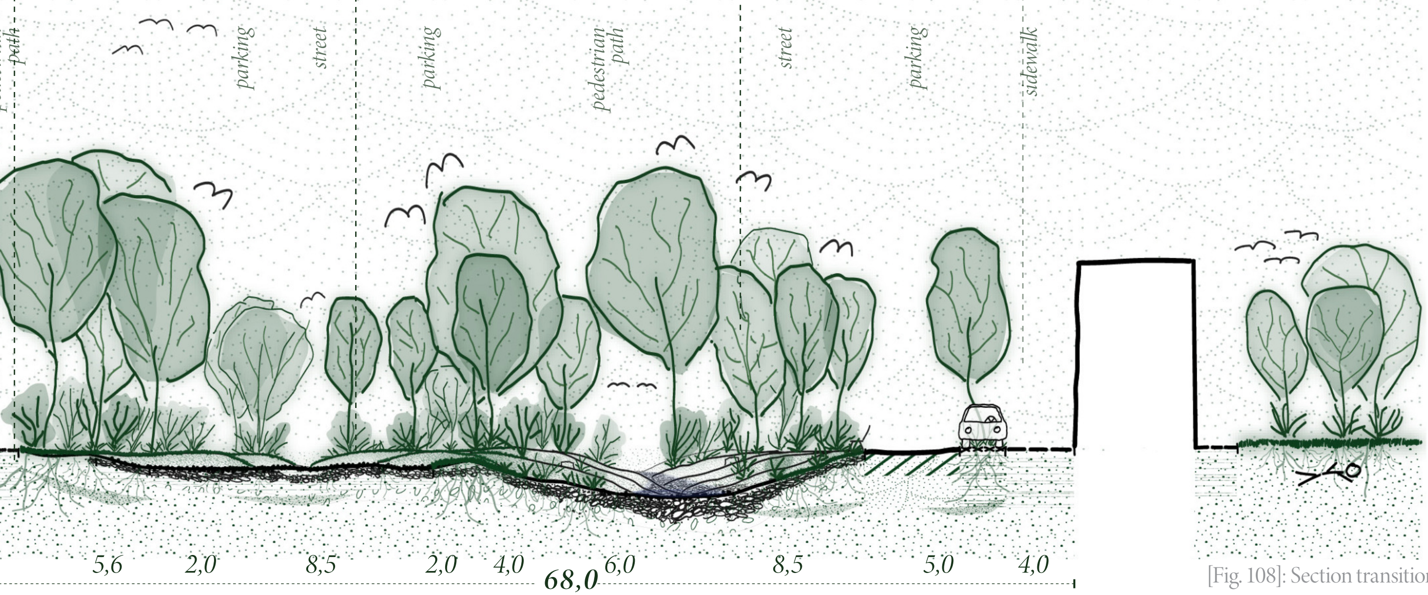
### Natural stream landscape as green corridor

Space for spreading waterstream bed with green shores as green corridor to foster biodiversity by daylighting

Daylighting is a technique to remove layers of concrete and recreate the natural shape and dynamic of streams, resulting in increased wildlife and aquatic habitat (Eisenbert and Polcher 2020).

### Shared streets & parking space reduction

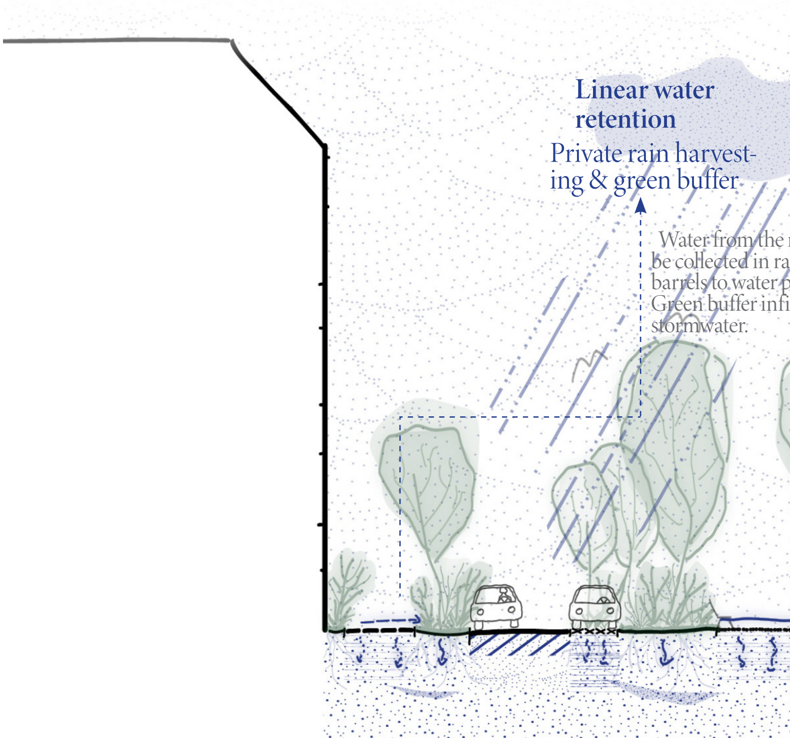
Reduce space for individual transport & private usage of public areas

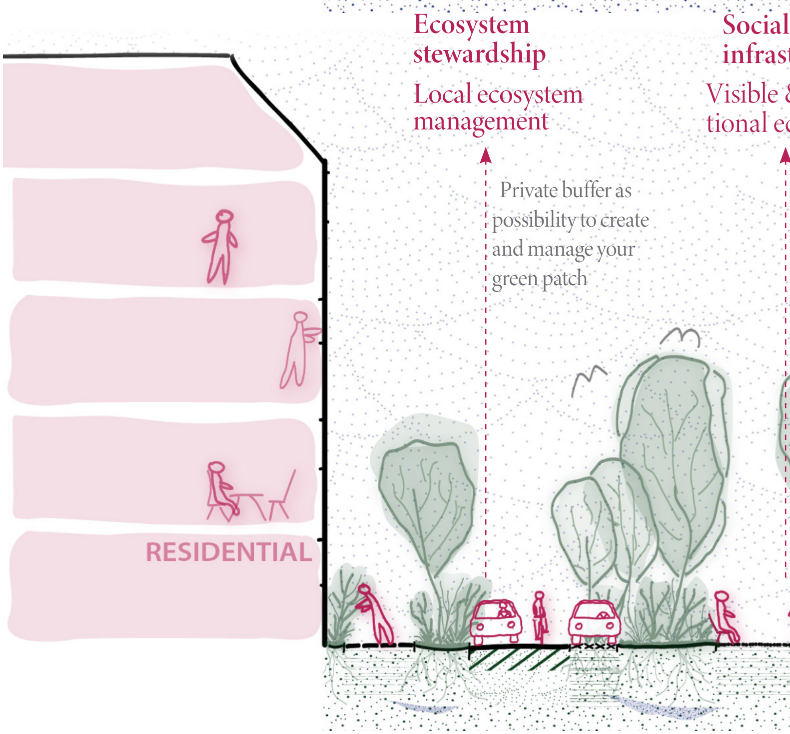


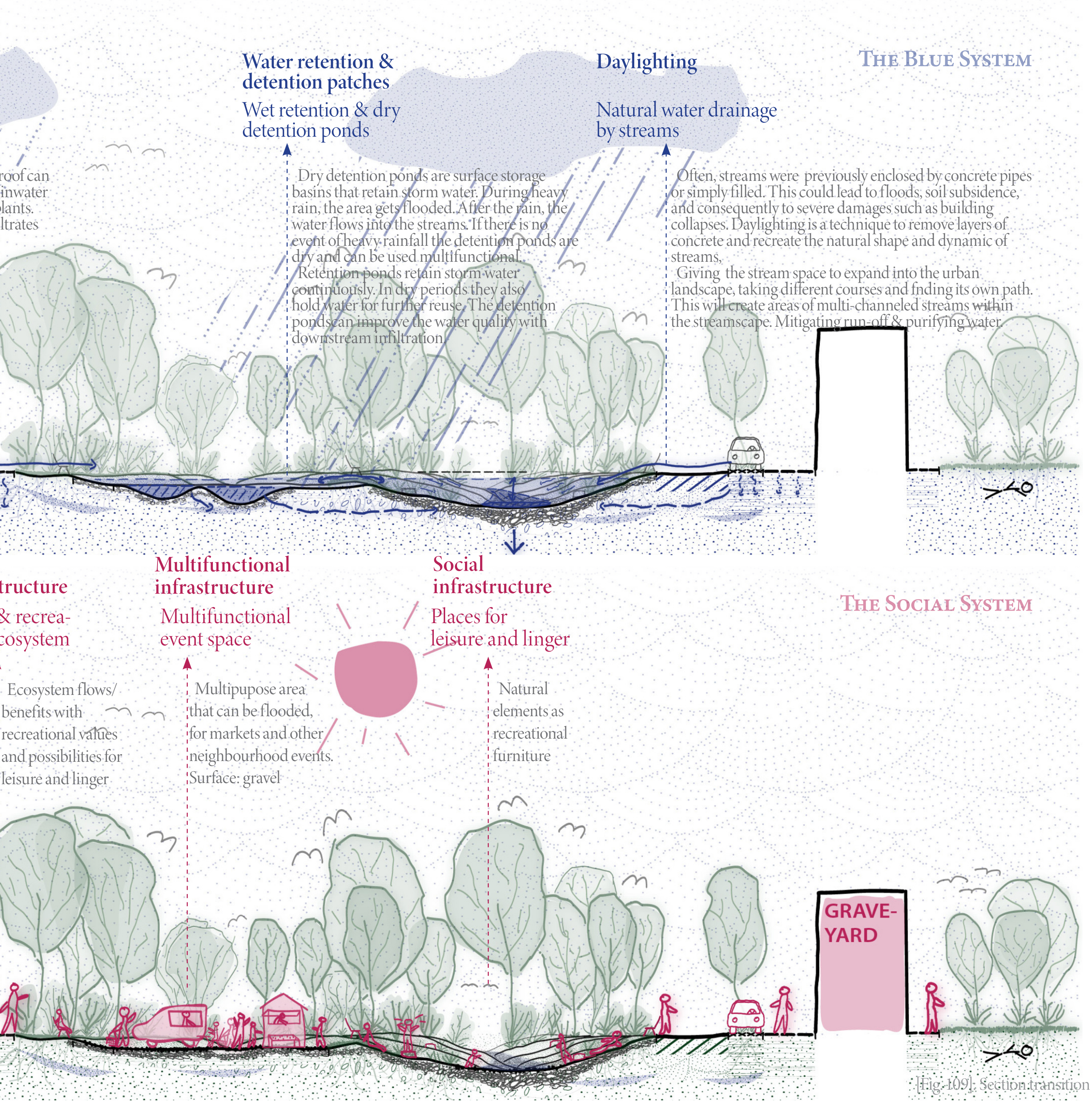

[Fig. 108]: Section transition

## B | Leopold-Kunschak-Platz

The integrated principles within the transitioned urban landscape are illustrated, showcasing water characteristics and social benefits.



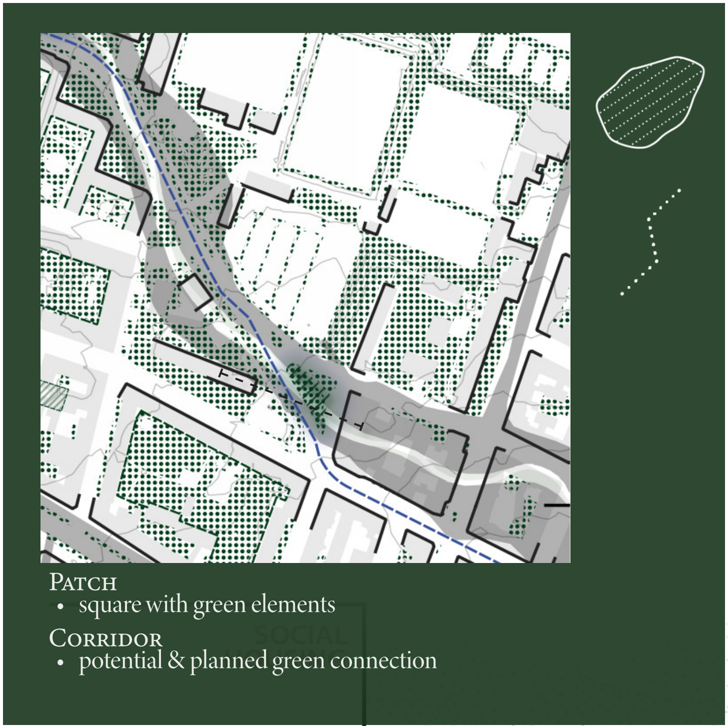



[Fig. 109]: Section transition

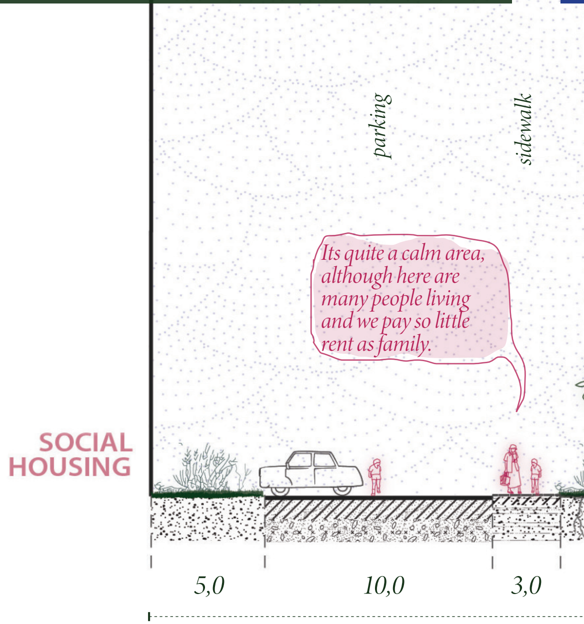
## c | Pezzlgasse

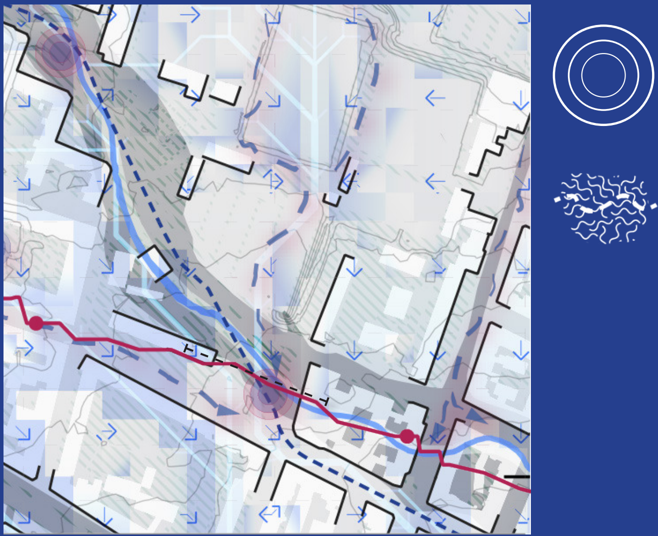
An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, showcasing demands and focal systems.



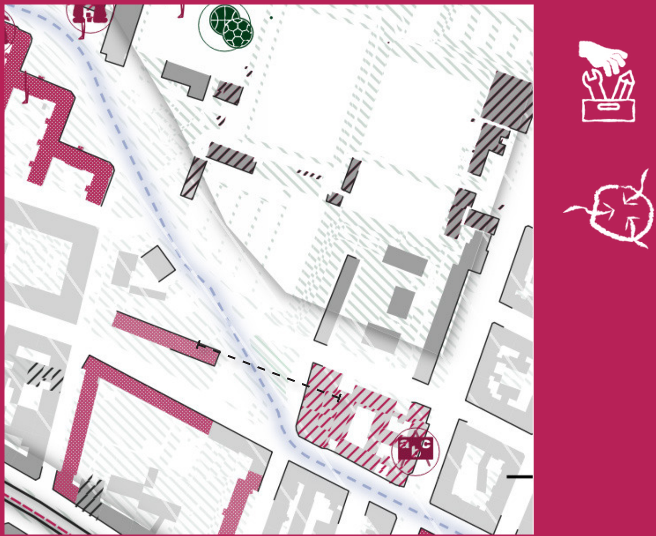



### The Present

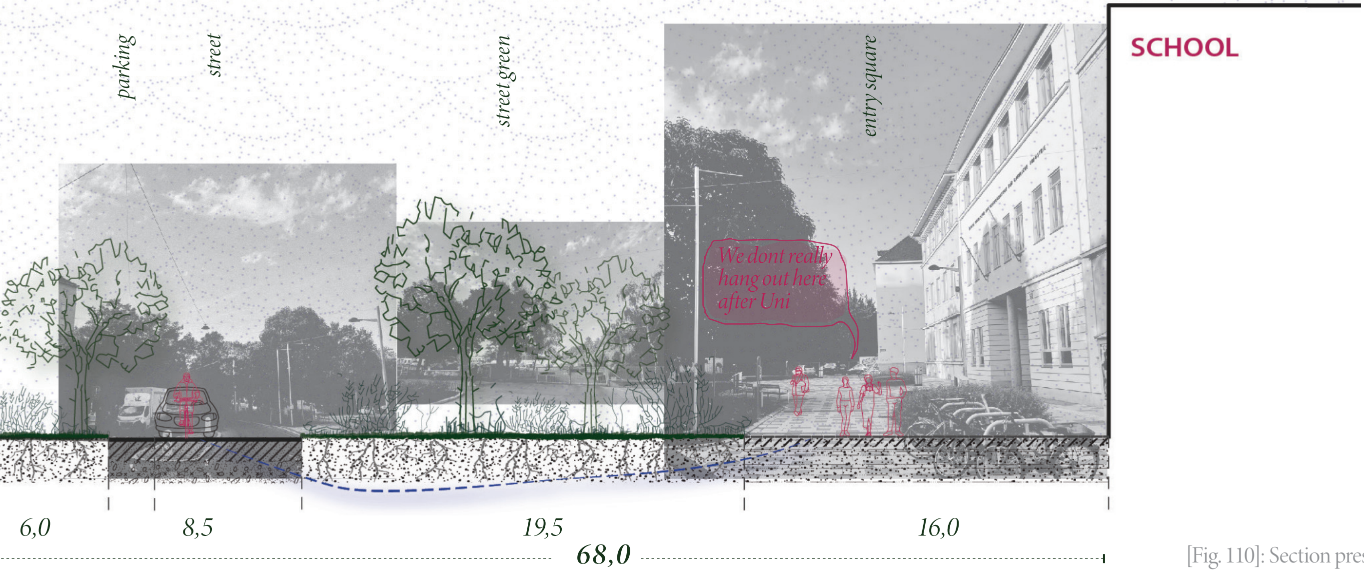




- mainly historical stream bed
- accumulation of water
- potential crossing point



- University and education center
- potential gathering point
- sourrounded by social housing



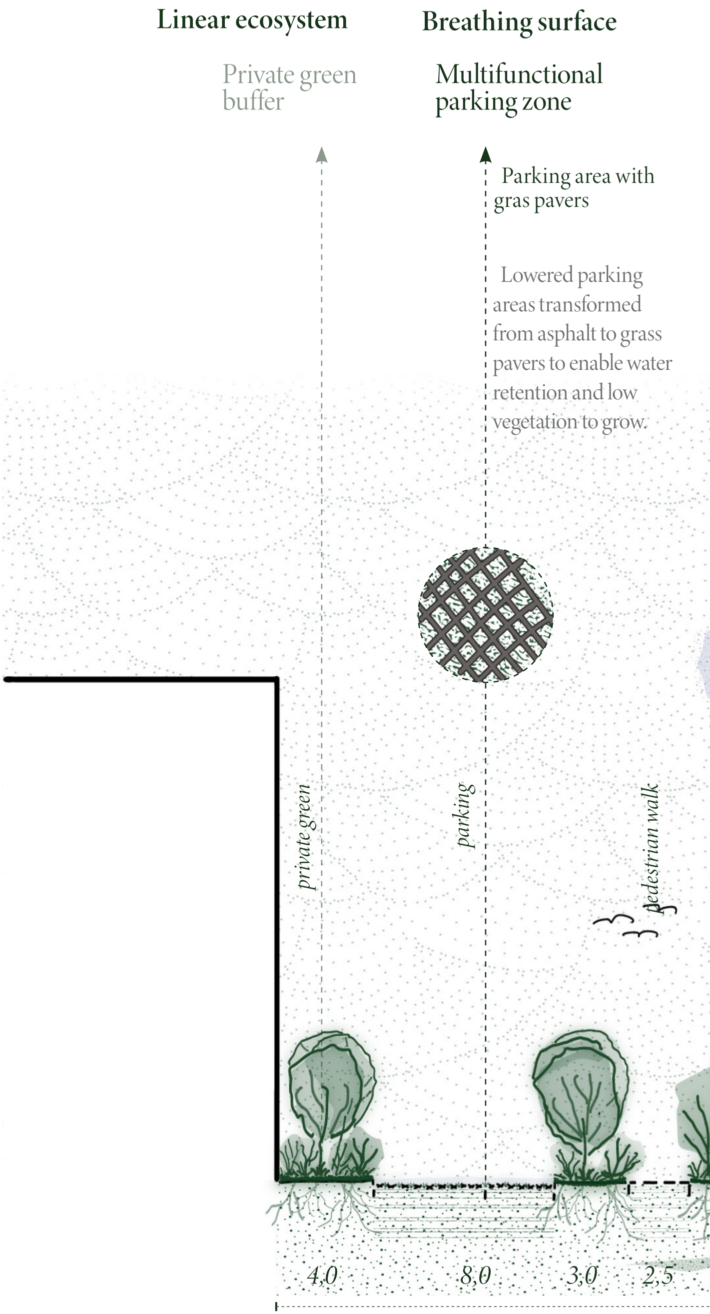

[Fig. 110]: Section present state

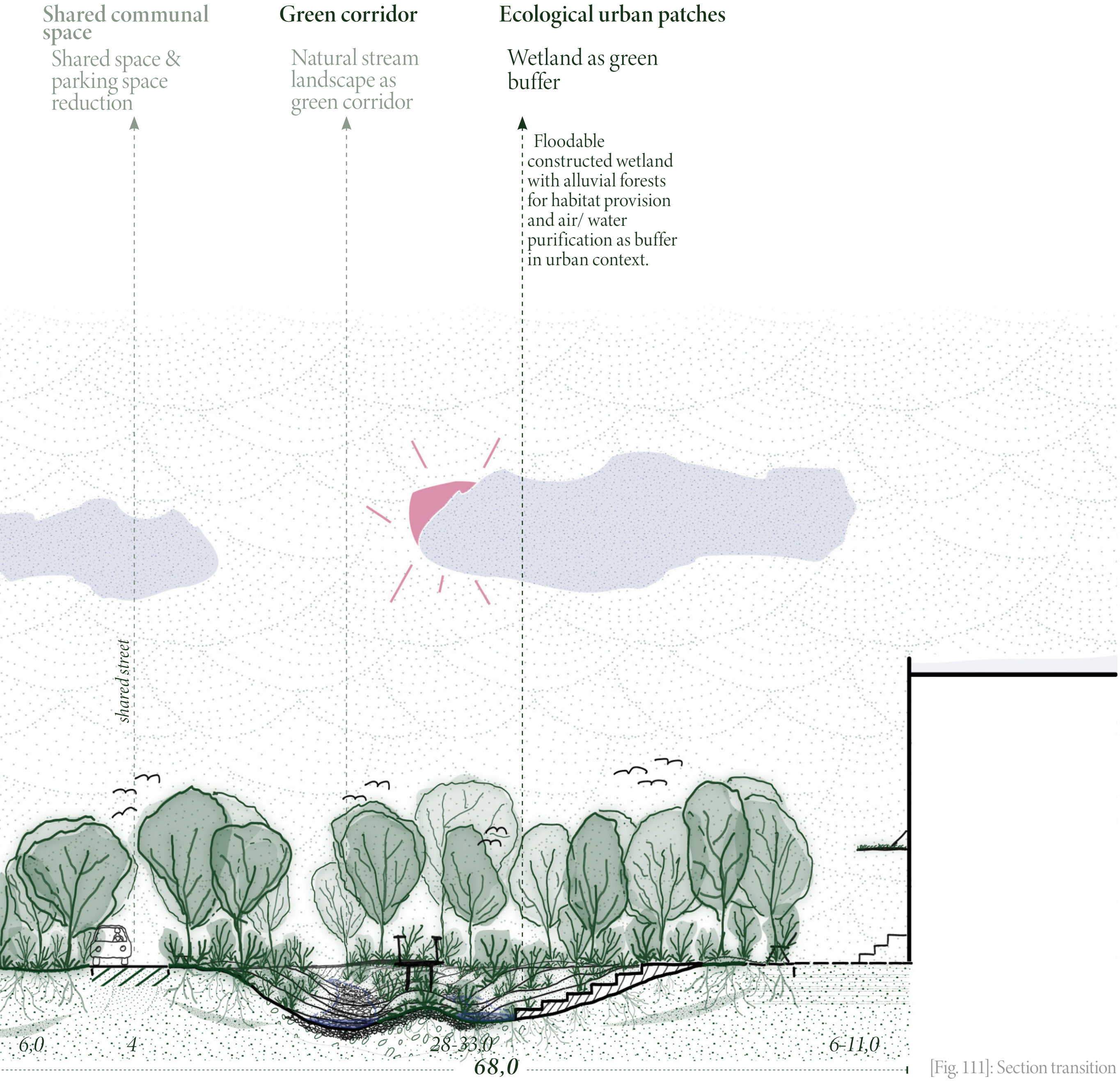
## c | Pezzlgasse

Systemic focus

Timeframe

This illustrates the systemic focus & the integrated principles within the transitioned & aspired climate-resilient urban landscape.

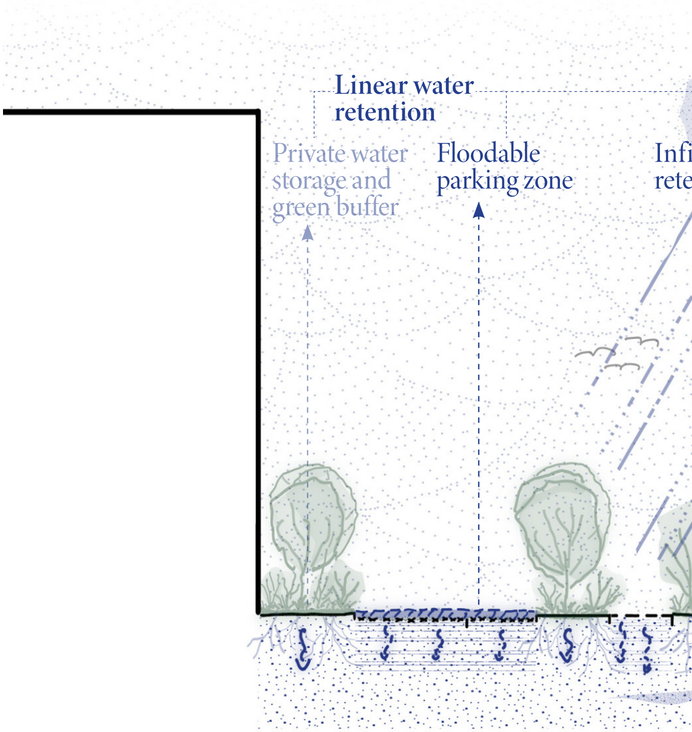


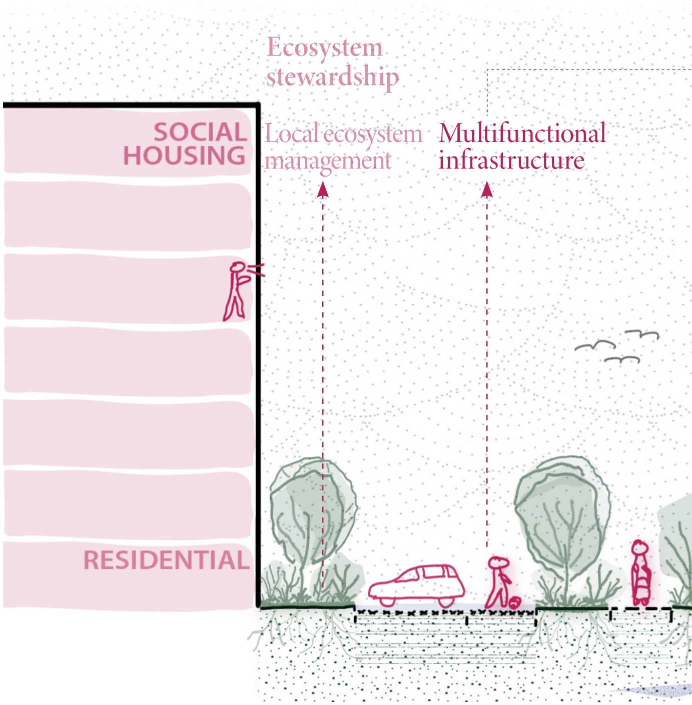


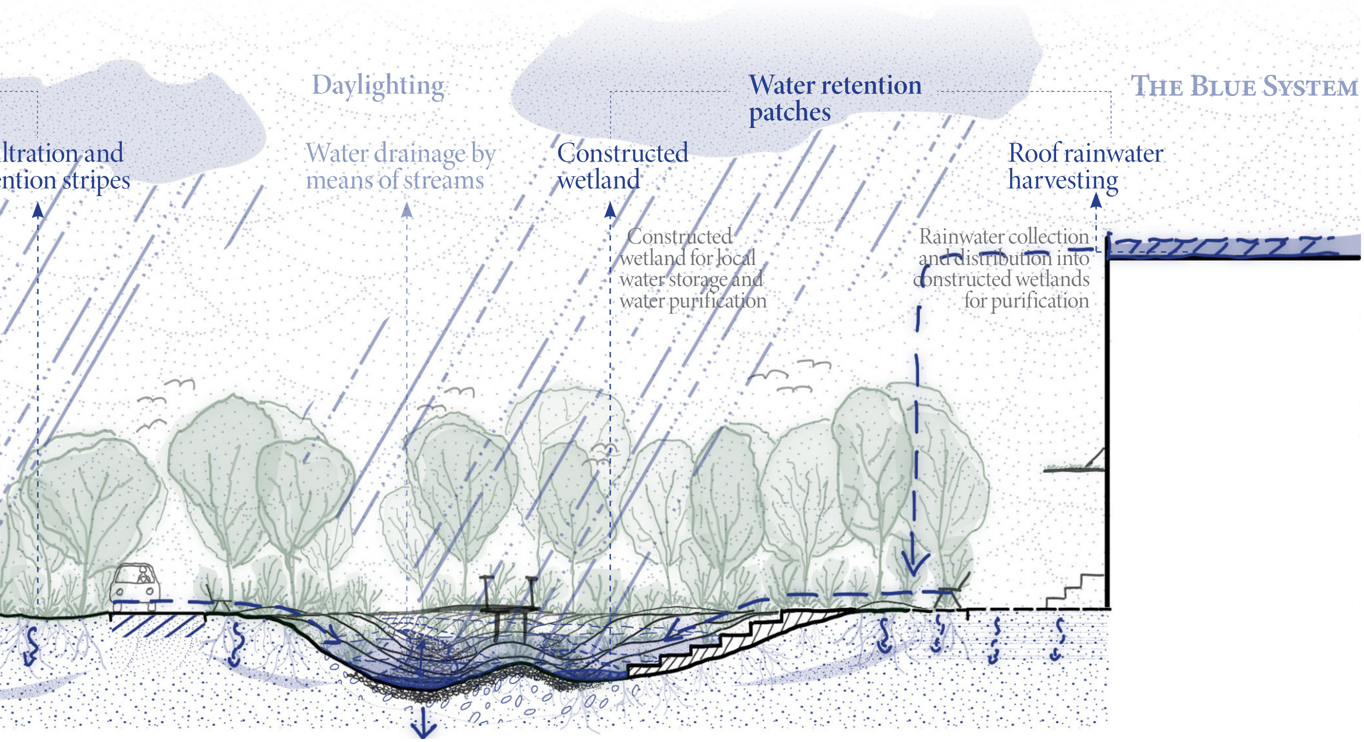

[Fig. 111]: Section transition

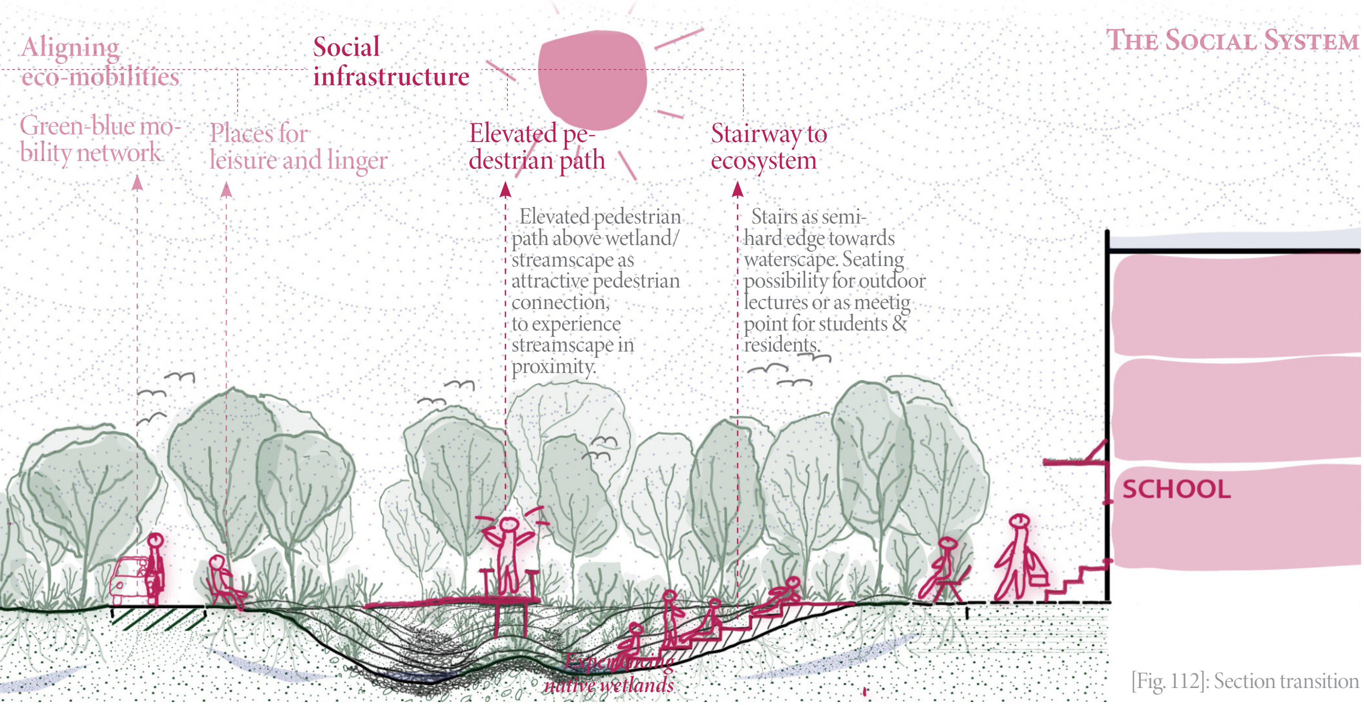
## c | Pezzlgasse

The integrated principles within the transitioned urban landscape are illustrated, showcasing water characteristics and social benefits.



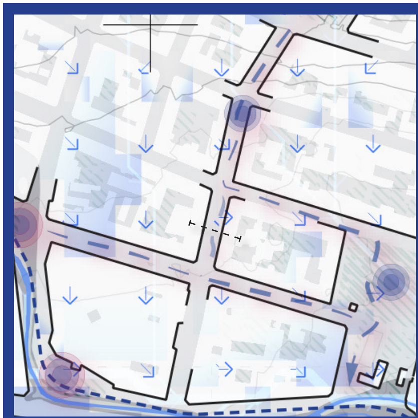


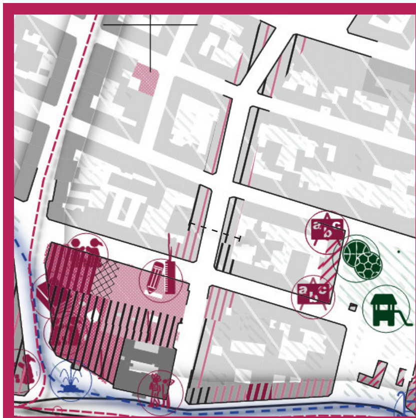

[Fig. 112]: Section transition

## D | Kalvarienberggasse

Corridor
- potential green connection
- narrow street profile
- no important mobility connection
- focus on pedestrian & bikes

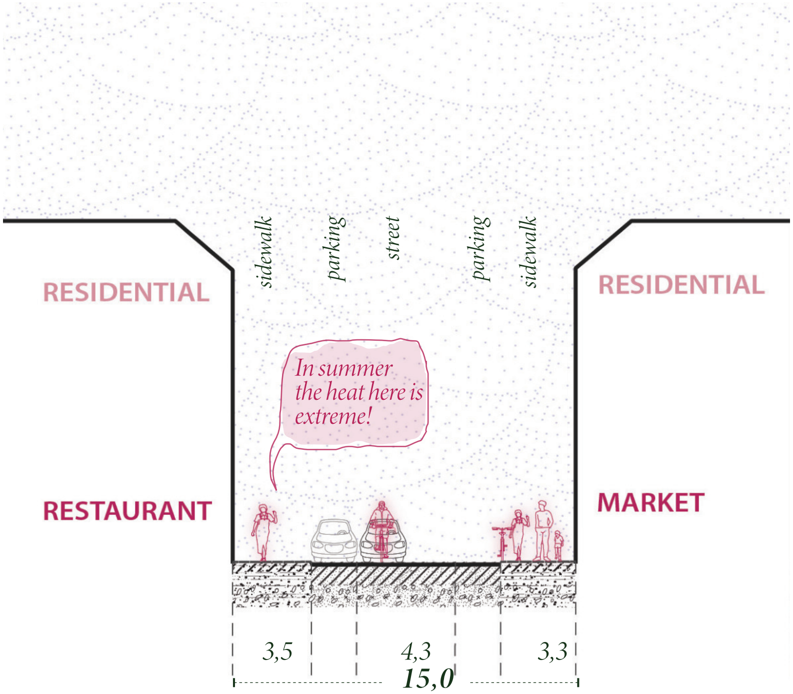


- terrestial slope
- natural water run-off possible
- no historical stream, mediocre infiltration



- Stores, restaurants
- commerce
- delivery neccessary






[Fig. 113]: Section present state

# E | Sankt-Bartholomäus-Platz

Patch
- urban square
- high sealing

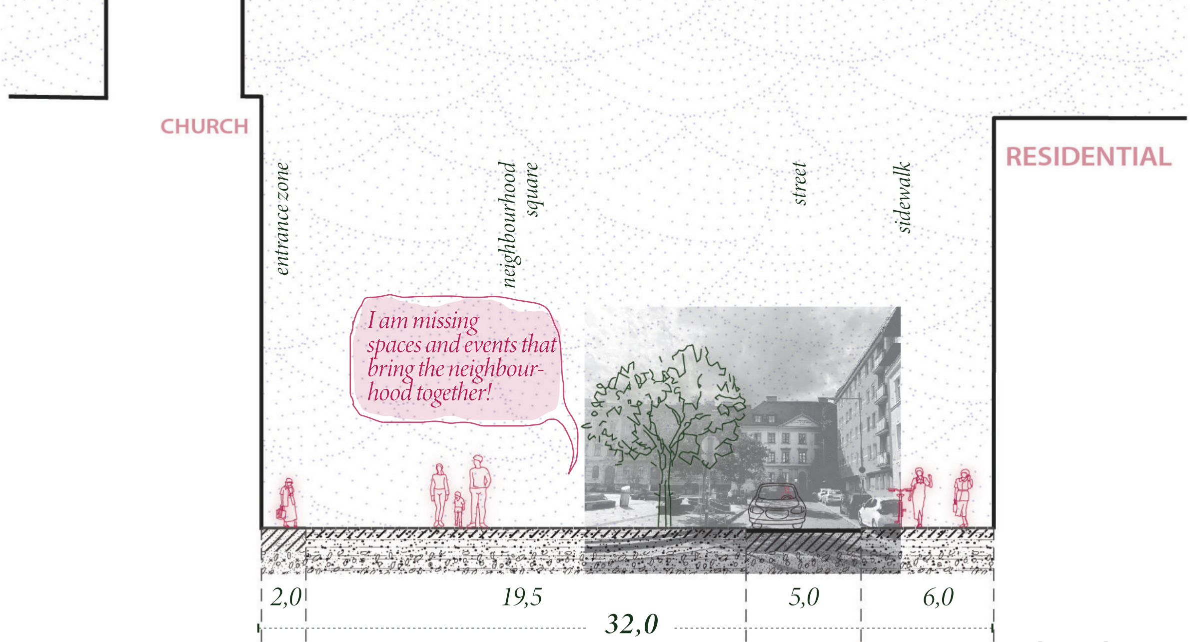
Corridor
- residential street profile

Patch
- sealed, accumulation
- mediocre infiltration

Corridor
- slight slope (street), natural water run-off

- school
- church
- community/ neighbourhood place
- communal character/ meeting point

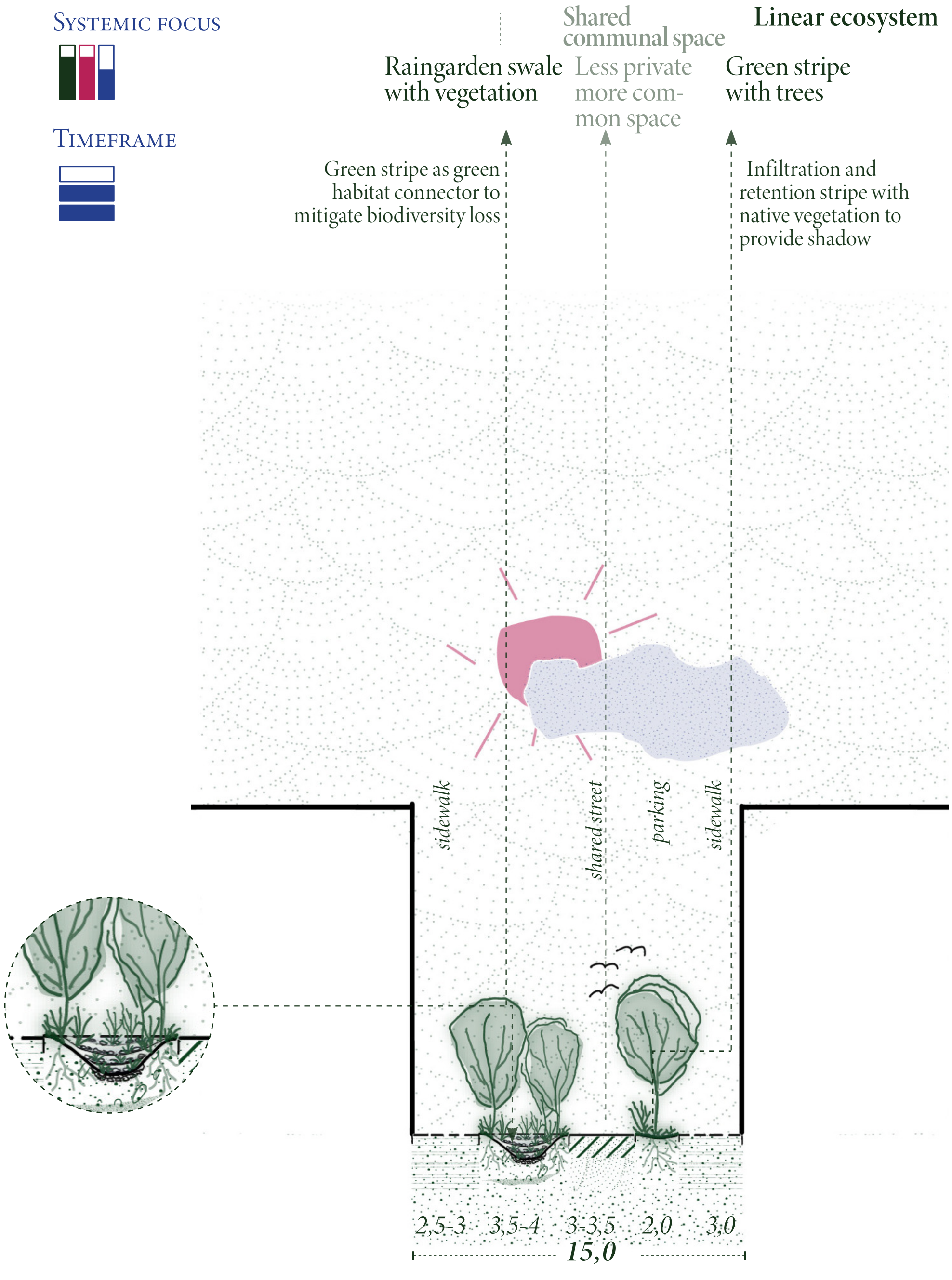
## The Present




[Fig. 114]: Section present state

Systemic focus

Timeframe




[Fig. 115]: Section transition

Systemic focus

Timeframe

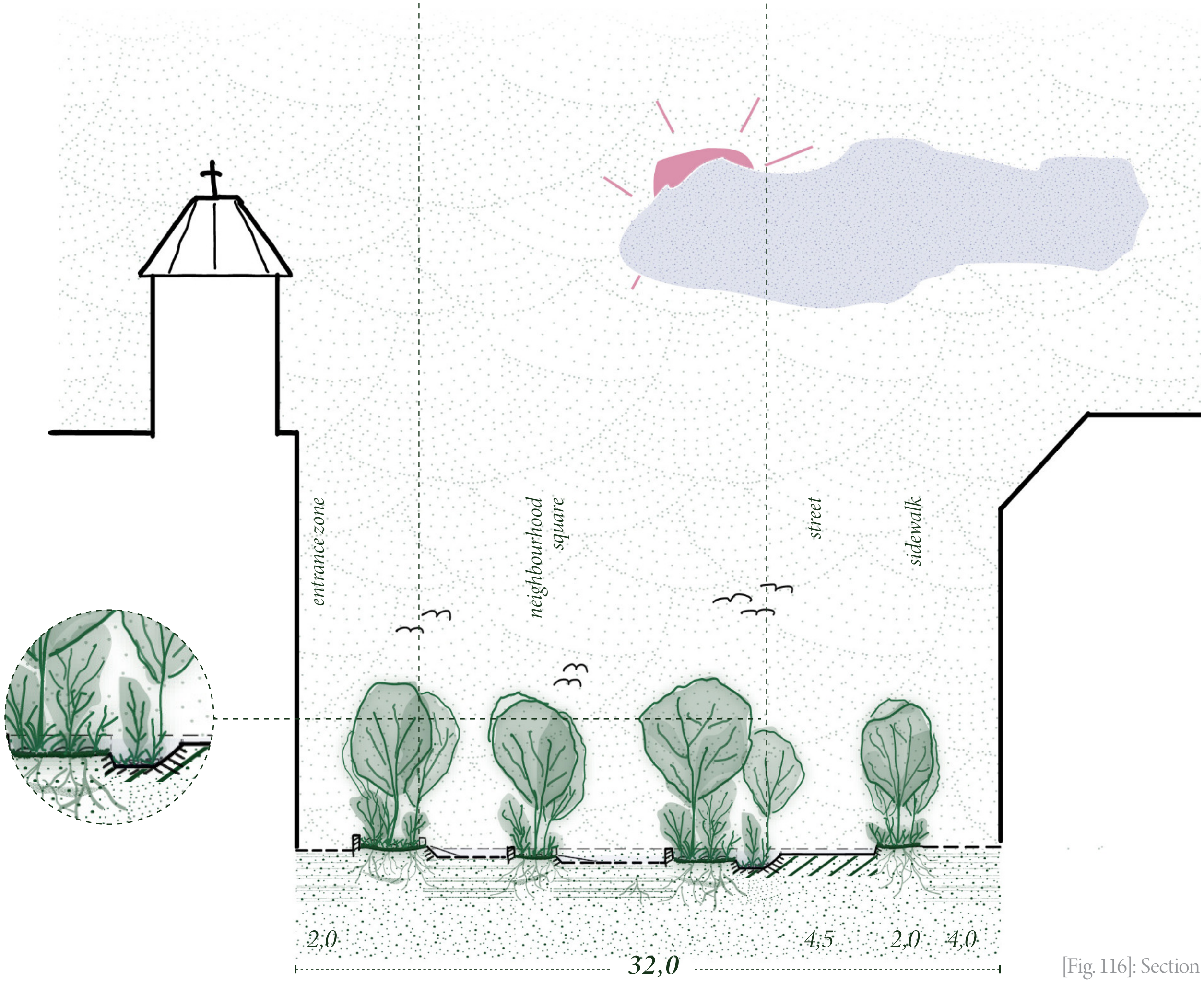
**Linear ecosystem**

Green buffers with vegetation

Green buffers to provide shadow, mitigate biodiversity loss, and infiltrate water

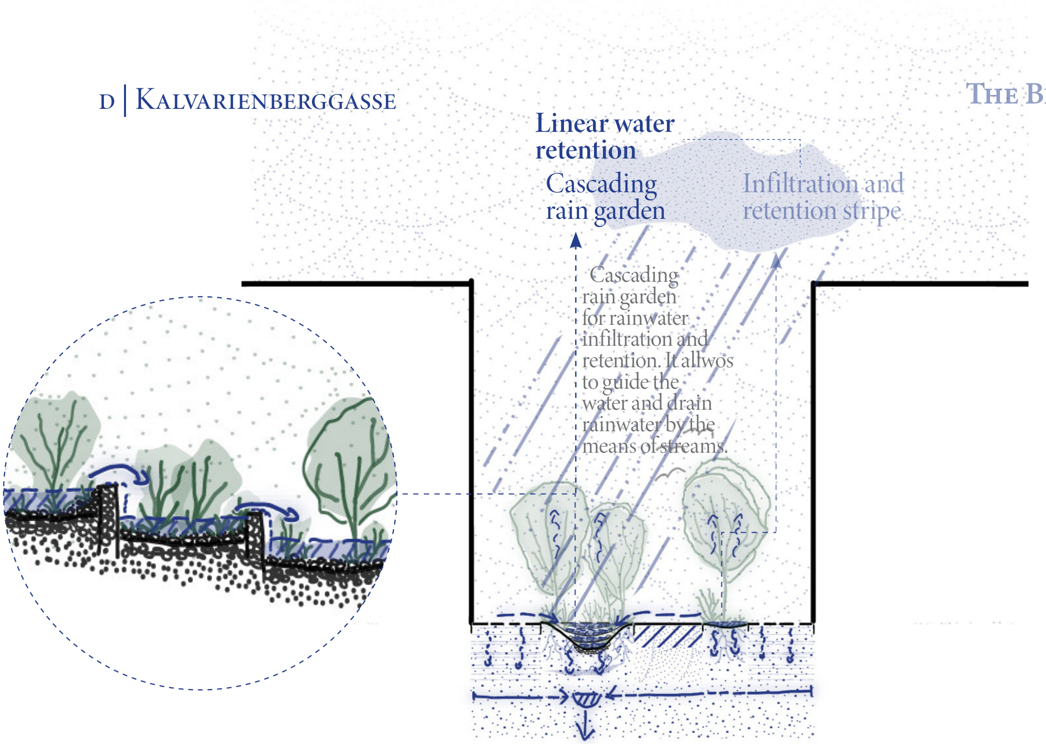
Canalized swale with vegetation

The canalized swale has hard edges and a layer of gravel and sand for water-loving purifiying plants



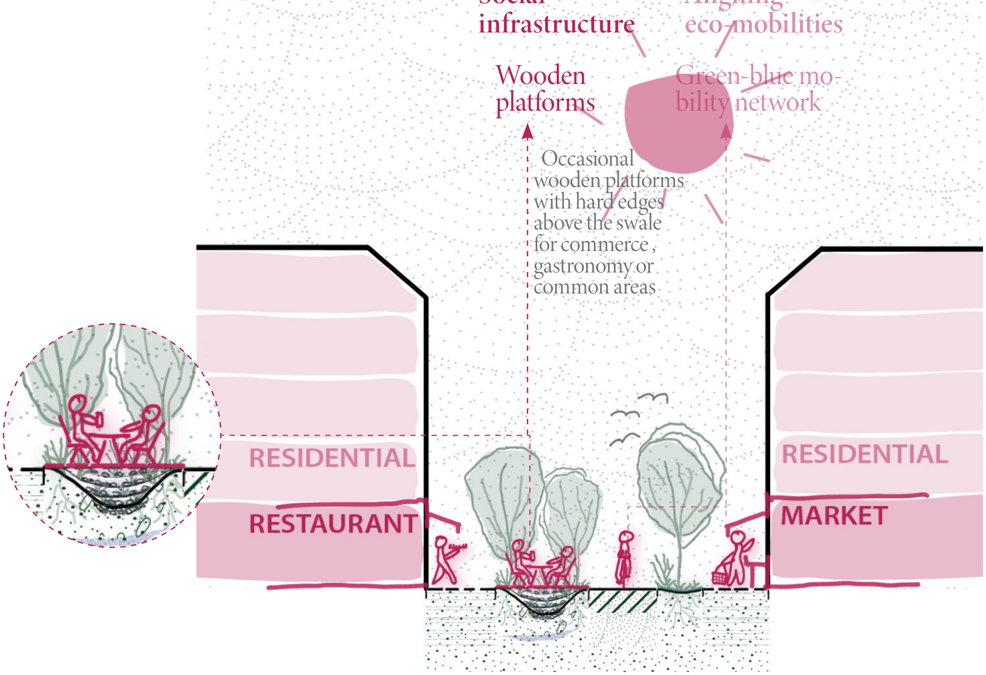

[Fig. 116]: Section transition

## The Blue System



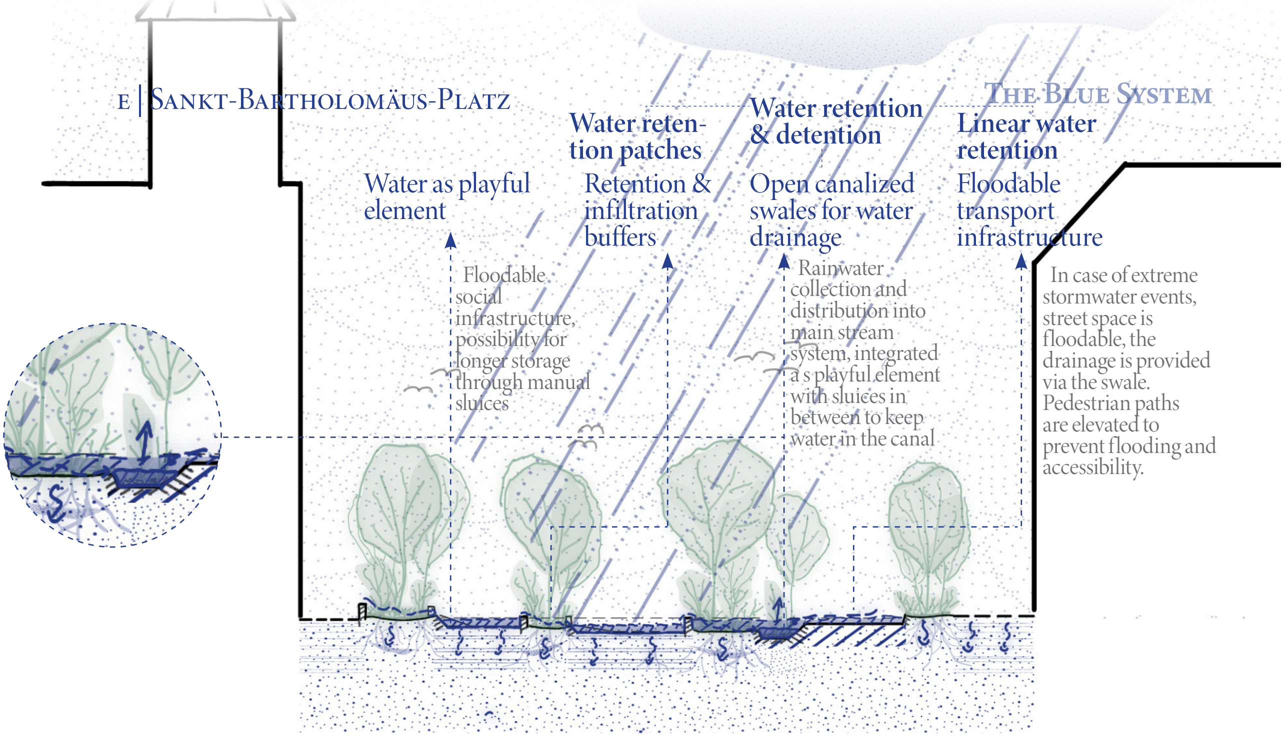


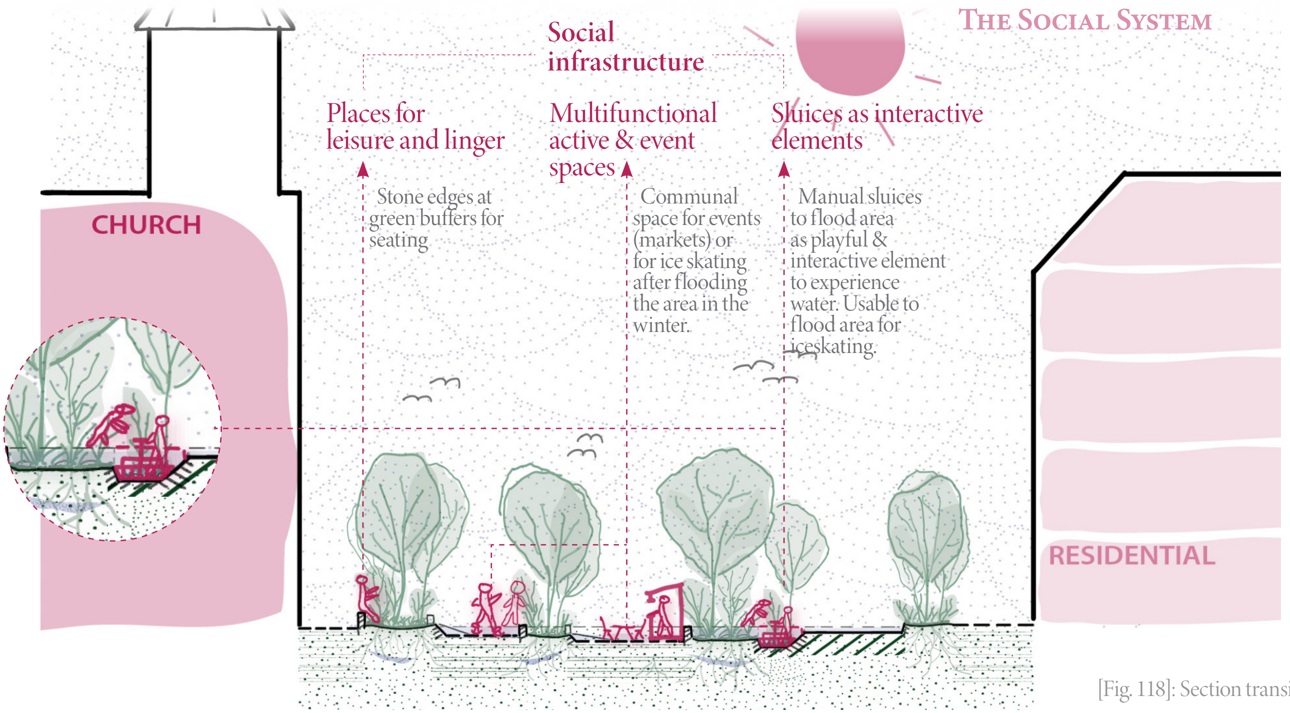

## The Social System




[Fig. 117]: Section transition

## e | Sankt-Bartholomäus-Platz

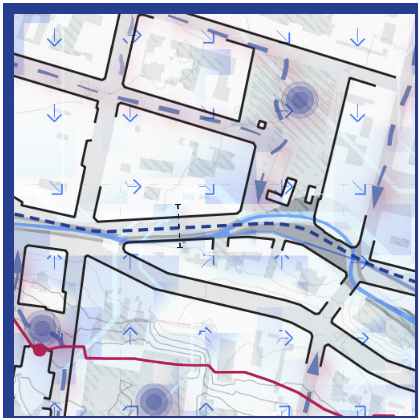


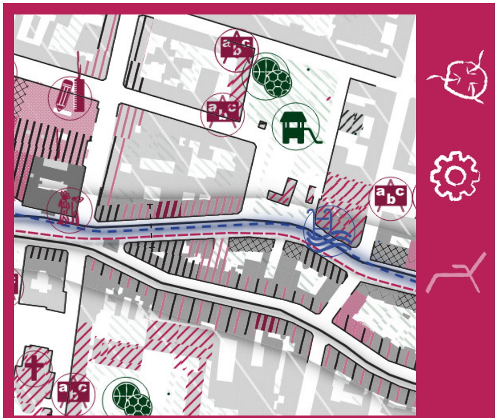

[Fig. 118]: Section transition

# F | Upper Jörgerstrasse

Corridor
- narrow street, high sealing
- important connection (tram)
- prioritized green connection
- potential pedestrian/ bike prioritization

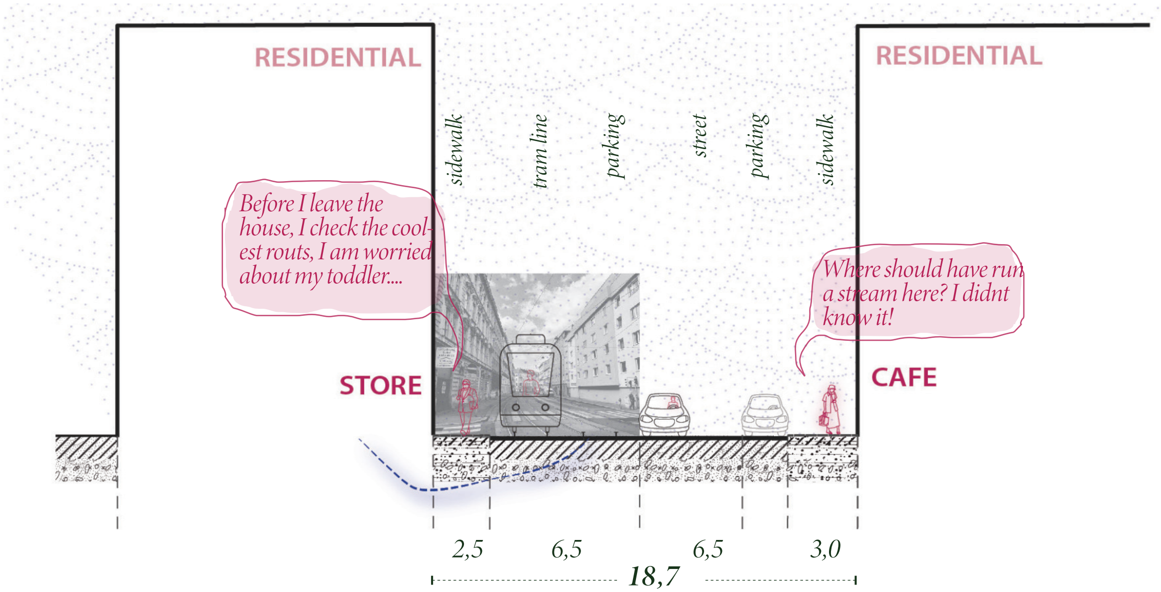


Corridor
- historical stream
- natural water run-off



- gastronomy
- stores
- delivery neccessary

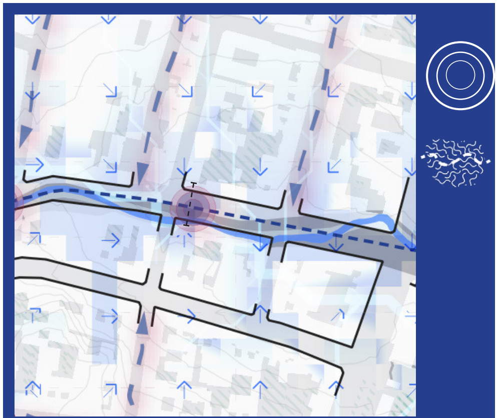




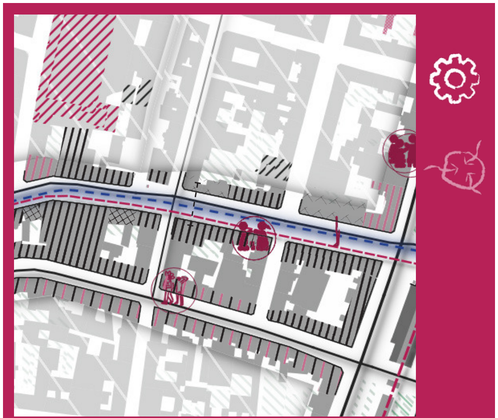

[Fig. 119]: Section present state

## G | Lower Jörgerstrasse

Corridor
- high frequented,
- important connection (tram, car)
- high sealing
- prioritized green connection

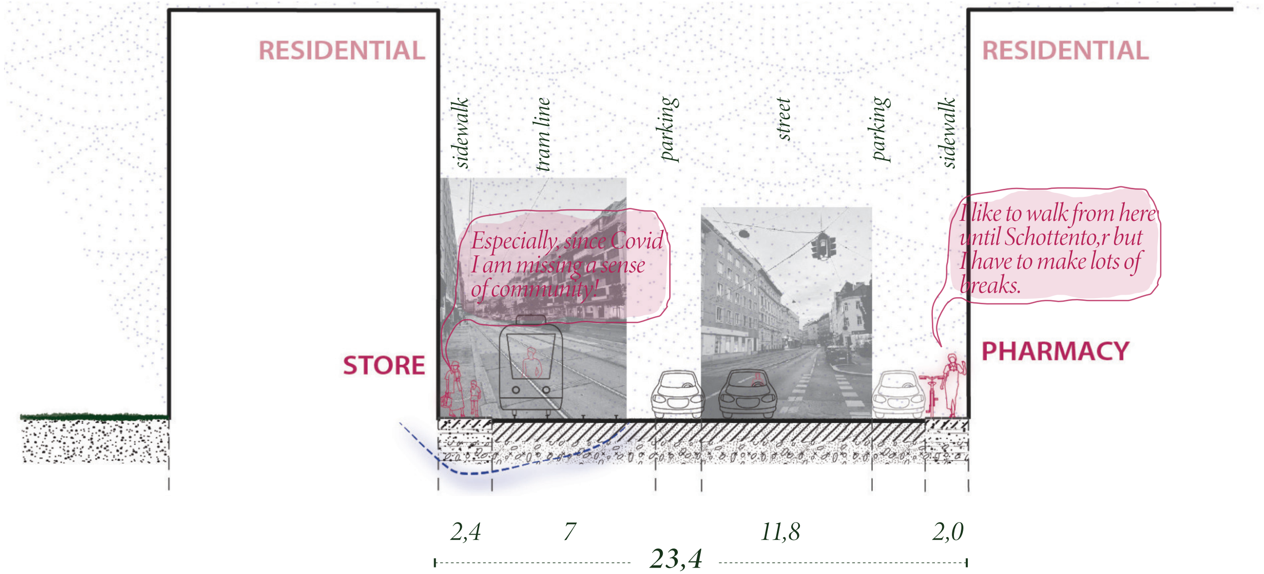


Corridor
- highly sealed
- natural accumulation of water
- historical stream



- commerce
- potential occasional gathering place

### The Present




[Fig. 120]: Section present state

## F | Upper Jörgerstrasse

### Systemic focus

### Timeframe

**Green connector**

Green tram bed

Low growing vegetation along the tram railway to provide green connection and infiltration

**Green corridor**

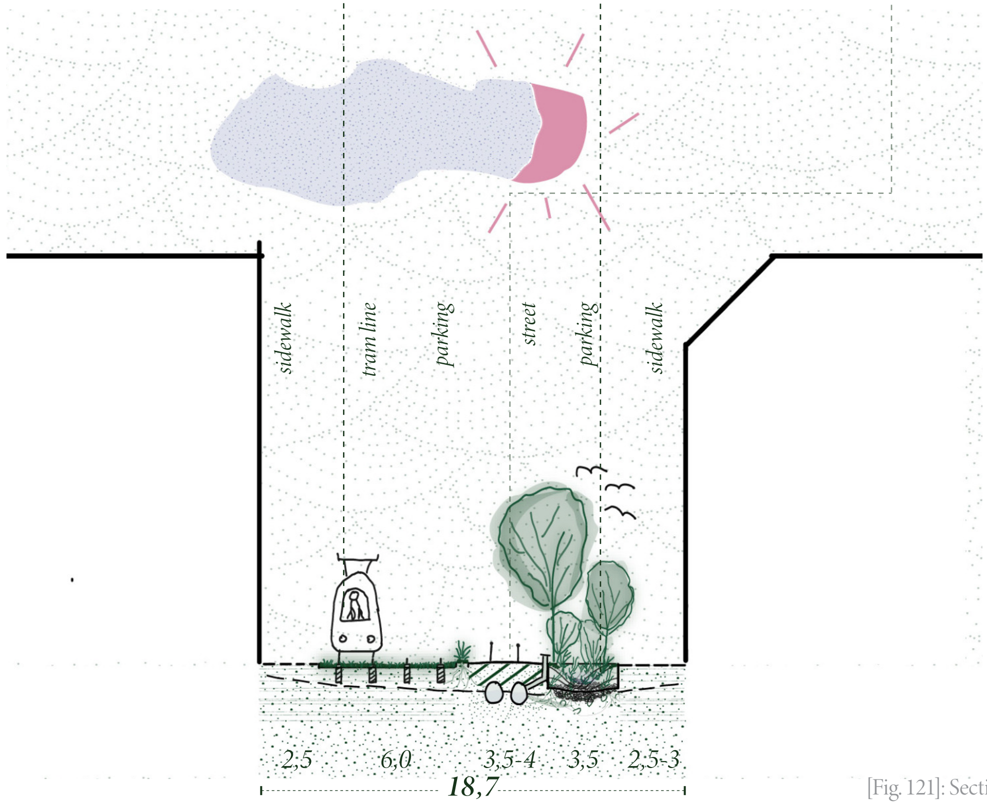
Canalized stream as green corridor

Streambed as green habitat connector, with hard edges and open sole, with vegetation and gravel banks

**Shared communal space**

Less private more common space






[Fig. 121]: Section transition

## G | Lower Jörgerstrasse

### Systemic focus

### Timeframe

**Green connector**

Green tram bed

Green stripe/ buffer with trees

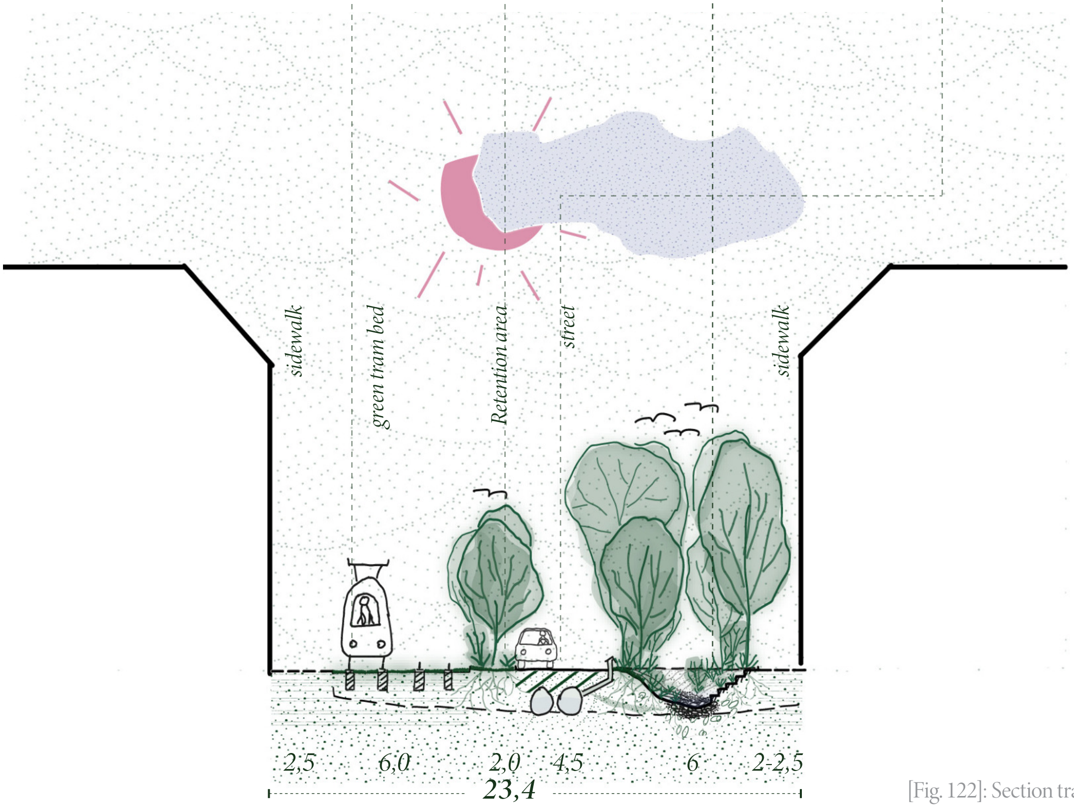
Infiltration and retention stripe with native vegetation to provide shadow and a natural buffer

**Green corridor**

**Semi-natural stream as green corridor**

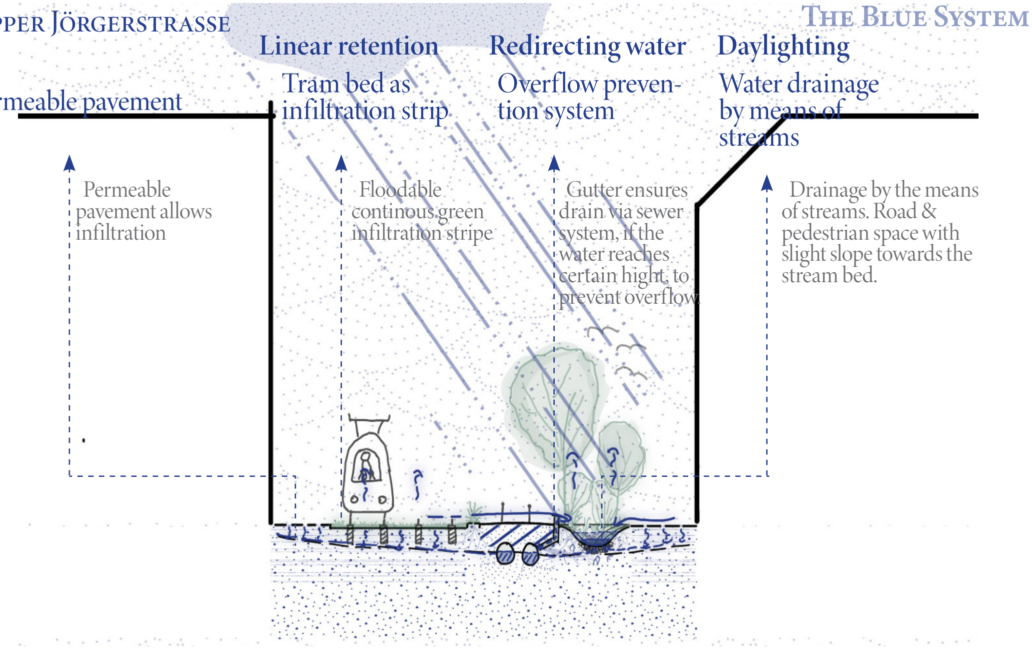
Streambed as green habitat connector, with open sole and one-sided natural shore

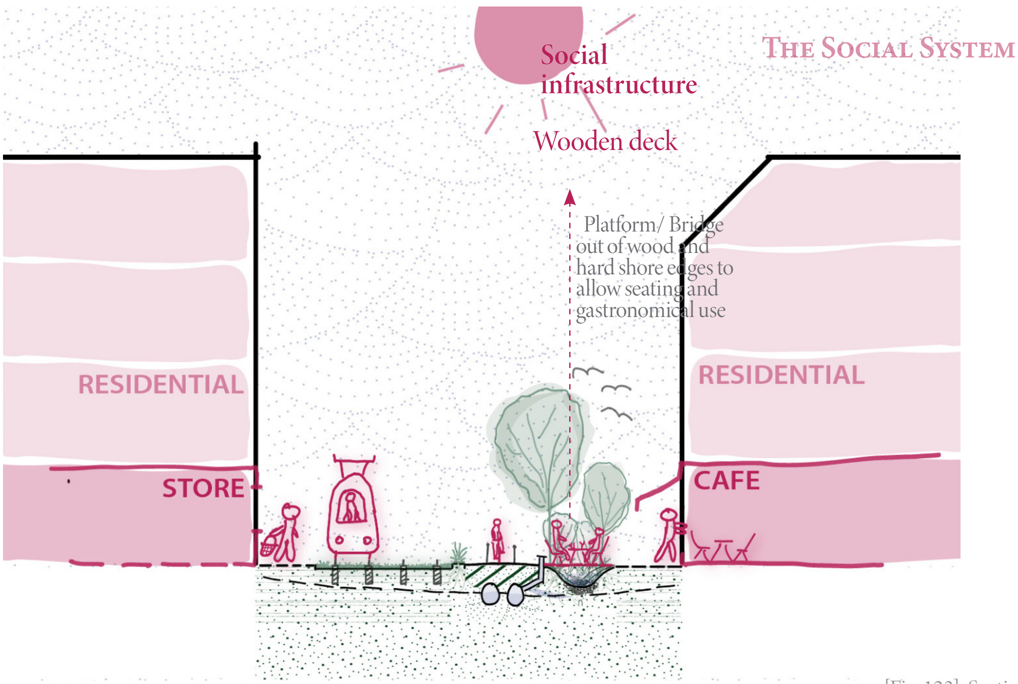
Less private more common space




[Fig. 122]: Section transition

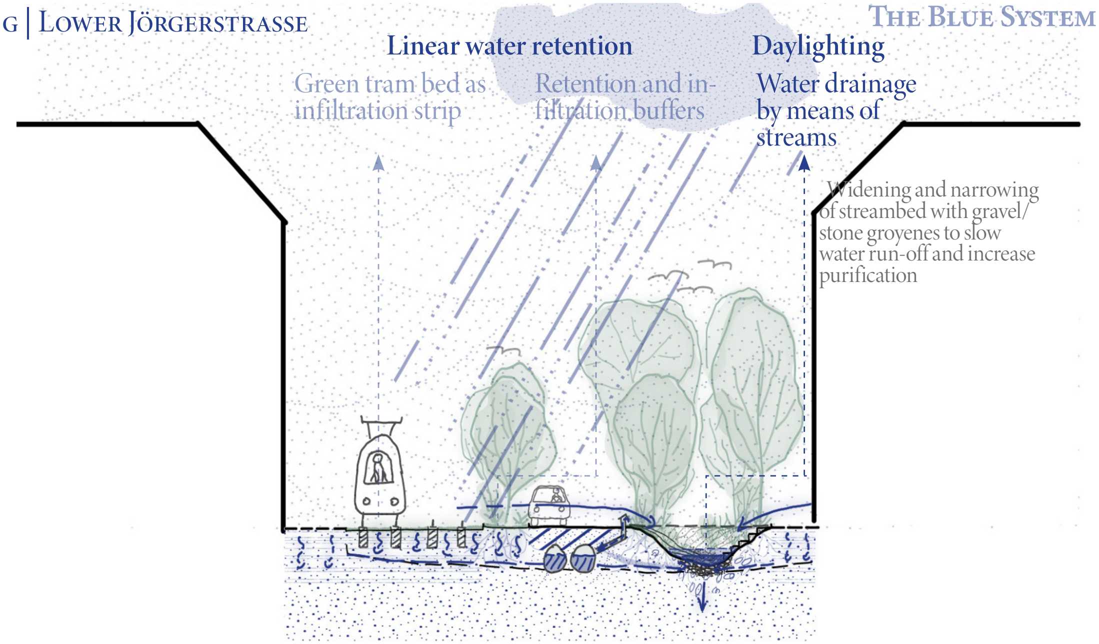
## F | Upper Jörgerstrasse

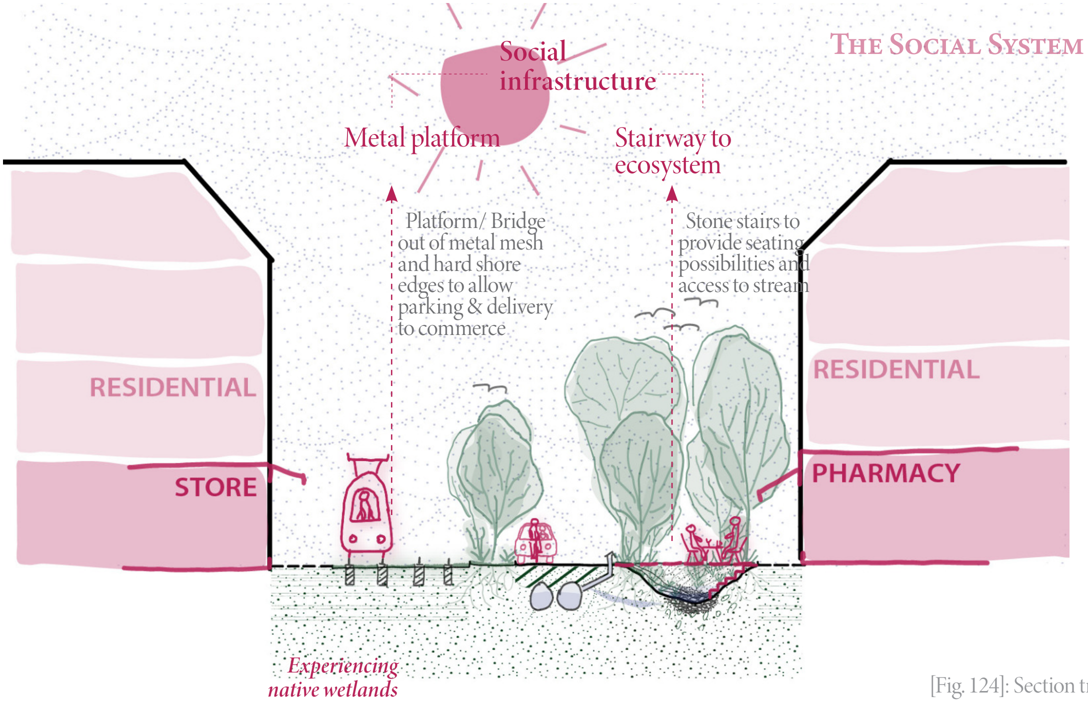



[Fig. 123]: Section transition

## G | Lower Jörgerstrasse




[Fig. 124]: Section transition

## 4.2.2 Profile: Favoriten

Favoriten, Vienna's 10th district, is the city's most populous area, home to about 200,000 residents (2020), constituting around 10% of Vienna's total population. Known for its high density, and high unemployment rates (around 12 %), Favoriten also boasts a significant foreign-born population, comprising 50% of its residents (City of Vienna, 2020; Molina et al., 2020).

The design exploration primarily focuses on the pedestrian zone of Favoritenstraße, a 1.3-kilometre stretch comprising five squares within walking distance of each other. These squares serve as sub-centres offering essential goods and services, catering particularly to low-income residents. However, while the upper section of Favoritenstraße sees high foot traffic, the lower part experiences lower activity levels, partly due to inadequate public spaces and high summer temperatures (Kroismayr et al., 2023). Referred to as the 'Favoriten Central Area,' this zone spans from Sonnwendplatz to Antonspark and encompasses Laxenburgerstrasse, Sonnwendgasse, and Herndlgasse (WKO Wien, 2015).



In recent years, Favoritenstraße has witnessed demographic shifts, notably with the influx of Syrian migrants. Consequently, the percentage of Austrian citizens in the area declined from 70% to 46% between 2001 and 2019 (Kroismayr et al., 2023).

The neighbourhood itself dates back to the late nineteenth and early twentieth centuries, with sporadic post-war buildings, increasingly towards the south & east . Its population density, at 330 residents per hectare, far surpasses the district average of 60 residents per hectare (Gruber and Jauschneg, 2016). Over the last decade, population growth has surged by 19% (Land Wien 2023). However, the dearth of green spaces, compounded by a lack of private gardens and minimal public green areas nearby, exerts immense pressure on the existing public spaces (Stadt Wien, 2020). According to local policy, there should be 4 m$^2$ of public space per resident within a 500-meter radius; however, at Reumannplatz, the largest square in the area, this figure stands at only 0.54 square meters (Gruber and Jauschneg, 2016).

As evident from my observations and documentation of the area [Fig.90], green and open spaces are scarce, with street spaces extensively purposed for vehicular use, leaving residents heavily reliant on the pedestrian zone and its squares. With projected population growth and worsening climate conditions, the demand for green spaces will intensify, necessitating a significant integration of green infrastructure with social benefits and the conversion of sealed surfaces. However, this is complicated by the presence of the underground metro beneath the pedestrian zone.

**Notes:**
Right page [Fig 125]: The documentation of Favoriten reveals both its spatial attributes and deficiencies. This collection of urban elements, which delineate local contexts (Rowe 1978), highlights an absence of qualitative green systems within a predominantly built and sealed environment. The impressions were collected during a walking tour conducted as part of my field trip in Vienna.


Alfred-Böhm-Park
Wieselburger Gasse
Eisenstadtplatz
Antonspark
Favoritenstrasse
Columbusgasse
Das Betreten und Verunreinigen der Grünanlage ist nicht gestattet.
Hunde an der Leine führen!
Reumannplatz
Viktor-Adler-Park
Pedestrian zone
Favoritenstrasse
Keplerpark
Columbusplatz
Kepler Gasse
Columbusplatz/
Pedestrain zone
Sonnwendplatz

## Favoriten: The Green System

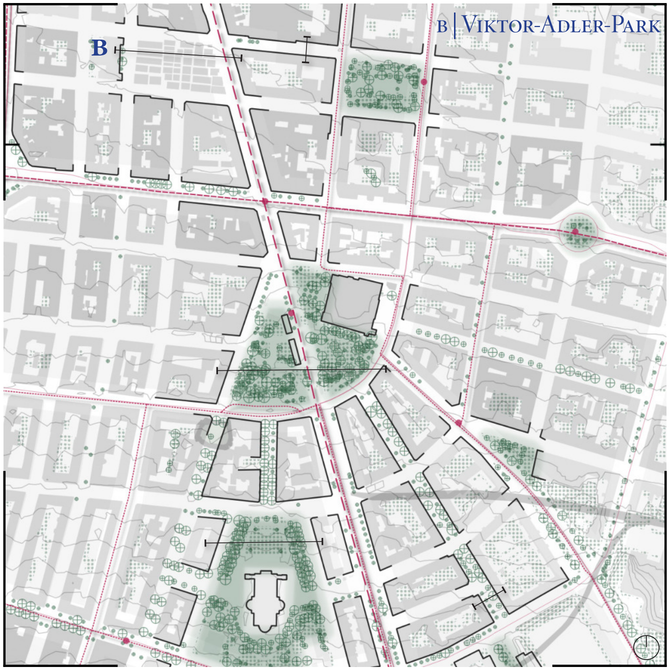
### Analysis

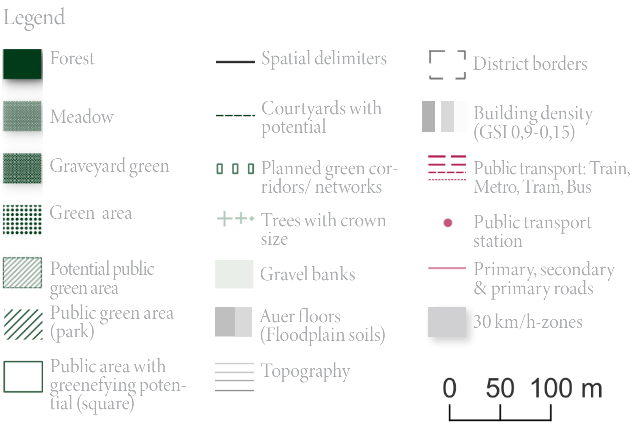
In Favoriten's south, extensive core biotopes thrive in Wienberg (east and west) and Laaerberg. Towards the denser city centre in the north, green spaces diminish, becoming more isolated and disconnected.

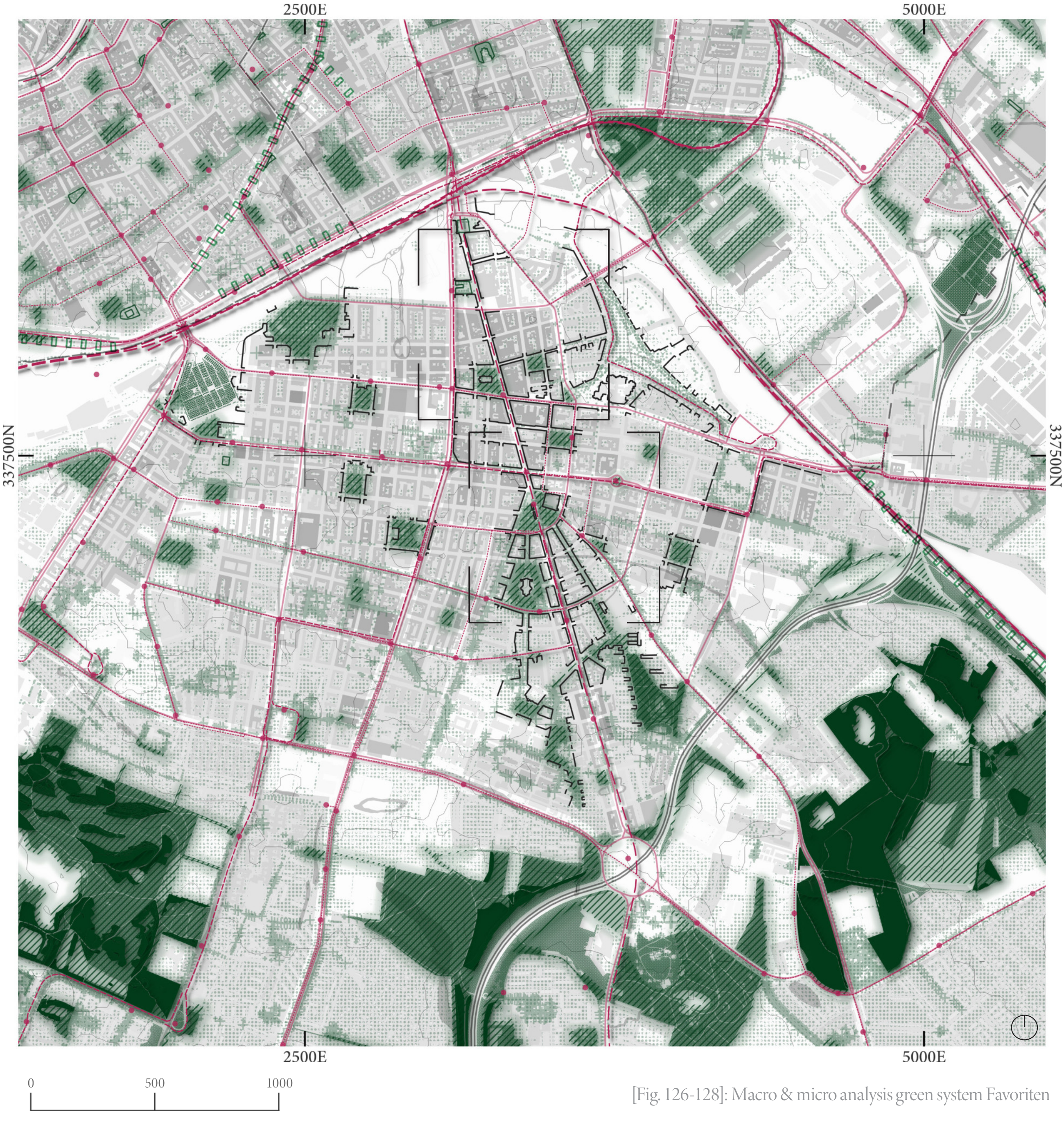
Railroad lines & the central train station in the north act as a physical barrier, hindering potential green connections & corridors to other biotopes in the city. Creating a variety of smaller green corridors could bridge gaps, linking dispersed green areas along Favoritenstraße and enhancing their role as ecosystem patches & nodes in a network.

The subway beneath Favoritenstraße offers excellent public access but limits subsoil usage and vegetation.

With cars dominating public street space, there's the need to reduce car space and allocate it to meet the demand for green and social areas for residents. A strategy to redistribute this space is the creation of car-poor superblocks, a concept already tested as "Supergrätzel" in Favoriten, in defined 30 km/h zones.



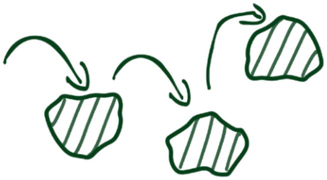

[Fig. 126-128]: Macro & micro analysis green system Favoriten

# Favoriten: The Green System

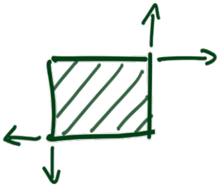
## Principles

- Multitude of green routes to ensure ecosystem connectivity

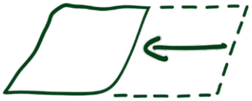
- Green connectors connecting green patches & "Supergrätzel" through green grid



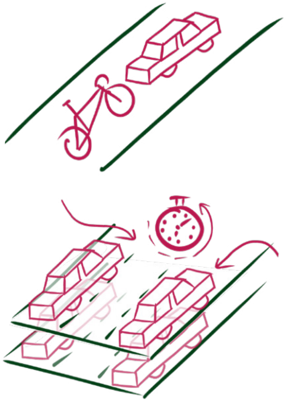
- Ecosystem patches as nodes in a network

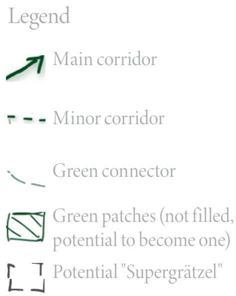


- Eco-mobility concept to reduce public space captured by cars



- Car-poor supergrätzel with shared streets & temporary/ collective parking





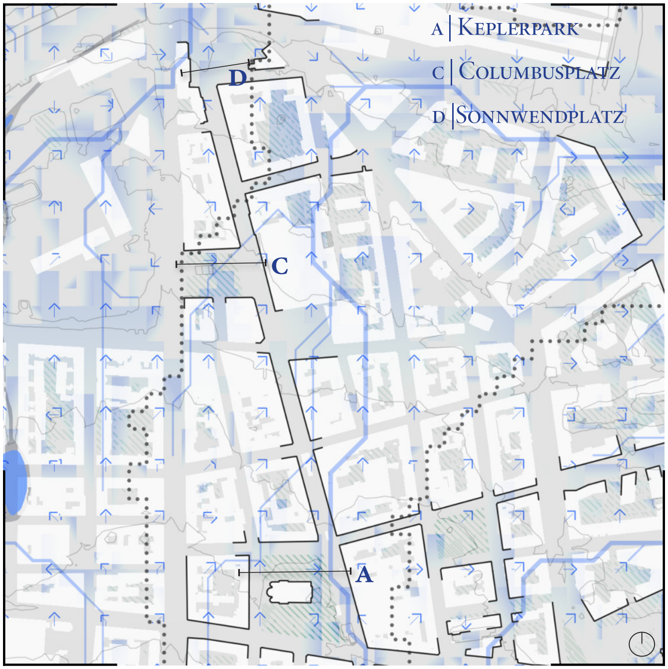

[Fig. 129]: Concept green system Favoriten

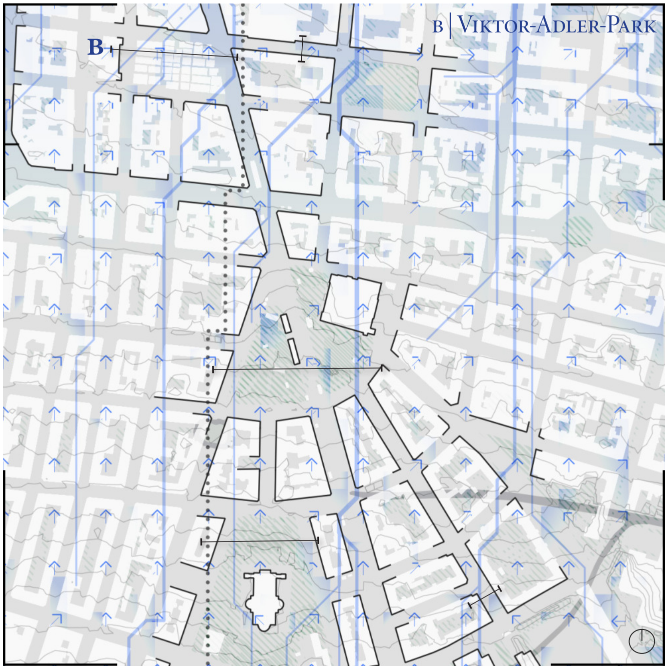
# Favoriten: The Blue System

## Analysis

Historically, the Favoriten area lacked a streamscape. The study area features terrace gravels from the Danube, with moderate to low-yielding groundwater. Exceptions include high-yielding groundwater in the gravel terraces closest to the Danube, to the north of Favoriten. The presence of low-yielding groundwater suggests limited water infiltration capacity in this area, as aquifer layers have a relatively low capacity to absorb and store water. However, this geological composition makes them ideal for diverting runoff water.

The area's topography, sloping downwards towards the north, naturally allows runoff water to drain superficially. While direct discharge into the Danube or Danube Canal may not be feasible, there are ample parklands/green spaces along the northern railway line suitable as retention areas to feed into the natural water cycle. Capitalizing on this potential enables the creation & water supply of green connections, enhancing climate resilience. Integrating wider spaces into the urban layout multifunctionally allows for water retention/detention areas, effectively slowing down water runoff and facilitating collection and storage for dry periods.

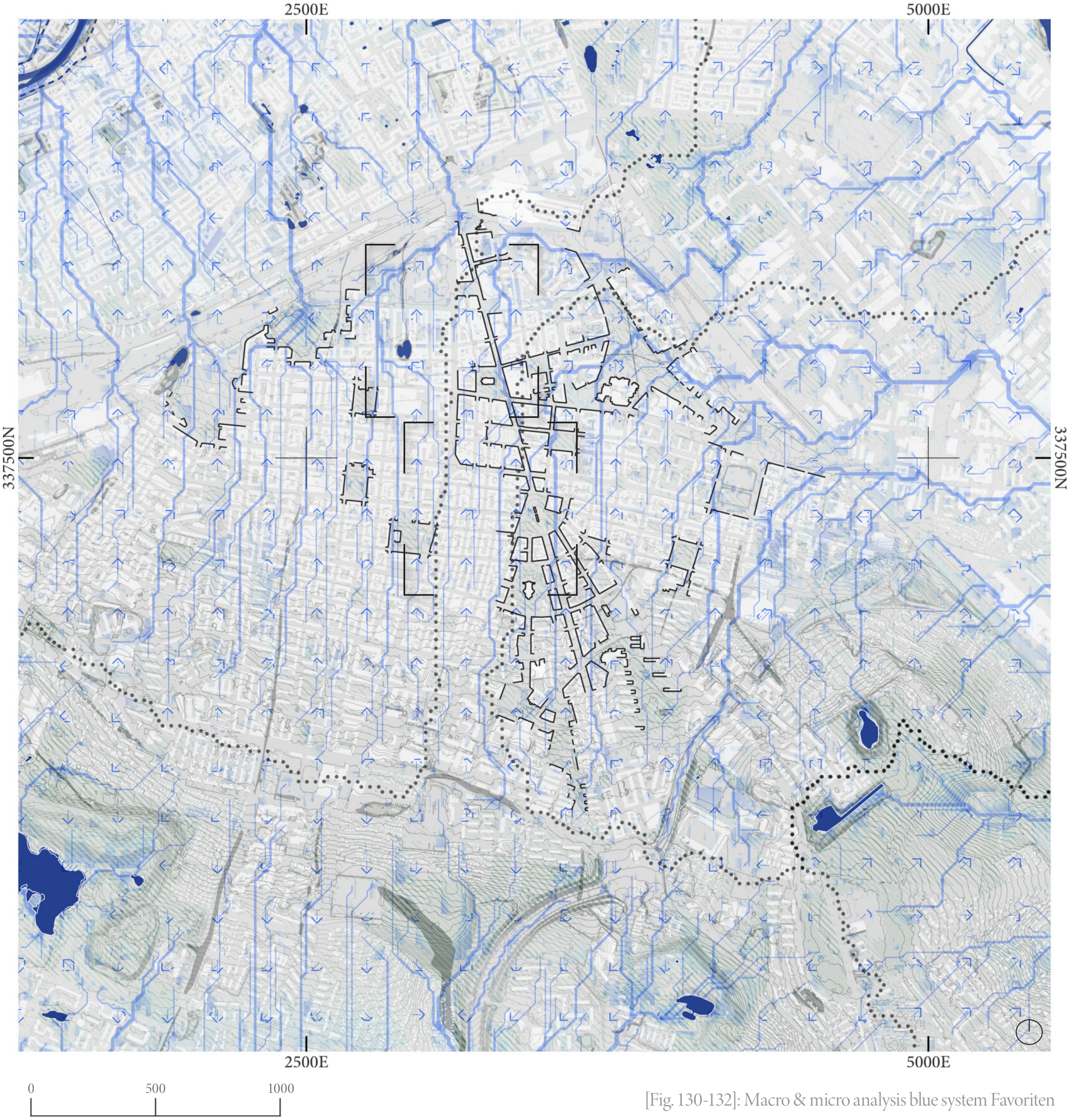



Legend

- Vienna canal/ streams
- Run-off floating direction
- Run-off floating patches
- Topography
- Catchment areas
- Course & accumulation of water based on topography & distribution
- Historic course of stream (1630)
- Gravel banks
- Auer floors (Floodplain soils)
- Green areas

0 50 100 m

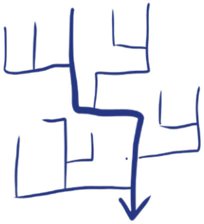



[Fig. 130-132]: Macro & micro analysis blue system Favoriten

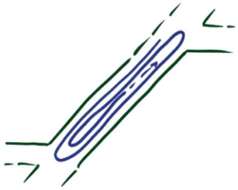
## Favoriten: The Blue System

### Principles

- Superficial rainwater drainage by guiding the water through the public space with canals, swales, etc.



- Water storage in Supergrätzel streets, when topography allows accumulation of water



- Canals & swales as means of guiding water, with hard edges in dense area & open sole to allow water to infiltrate where possible

- Use of accumulation (in patches or corridors) to change direction of natural water flow

- Parks/ squares (patches) as water accumulation points, to store & retain water in between

Legend

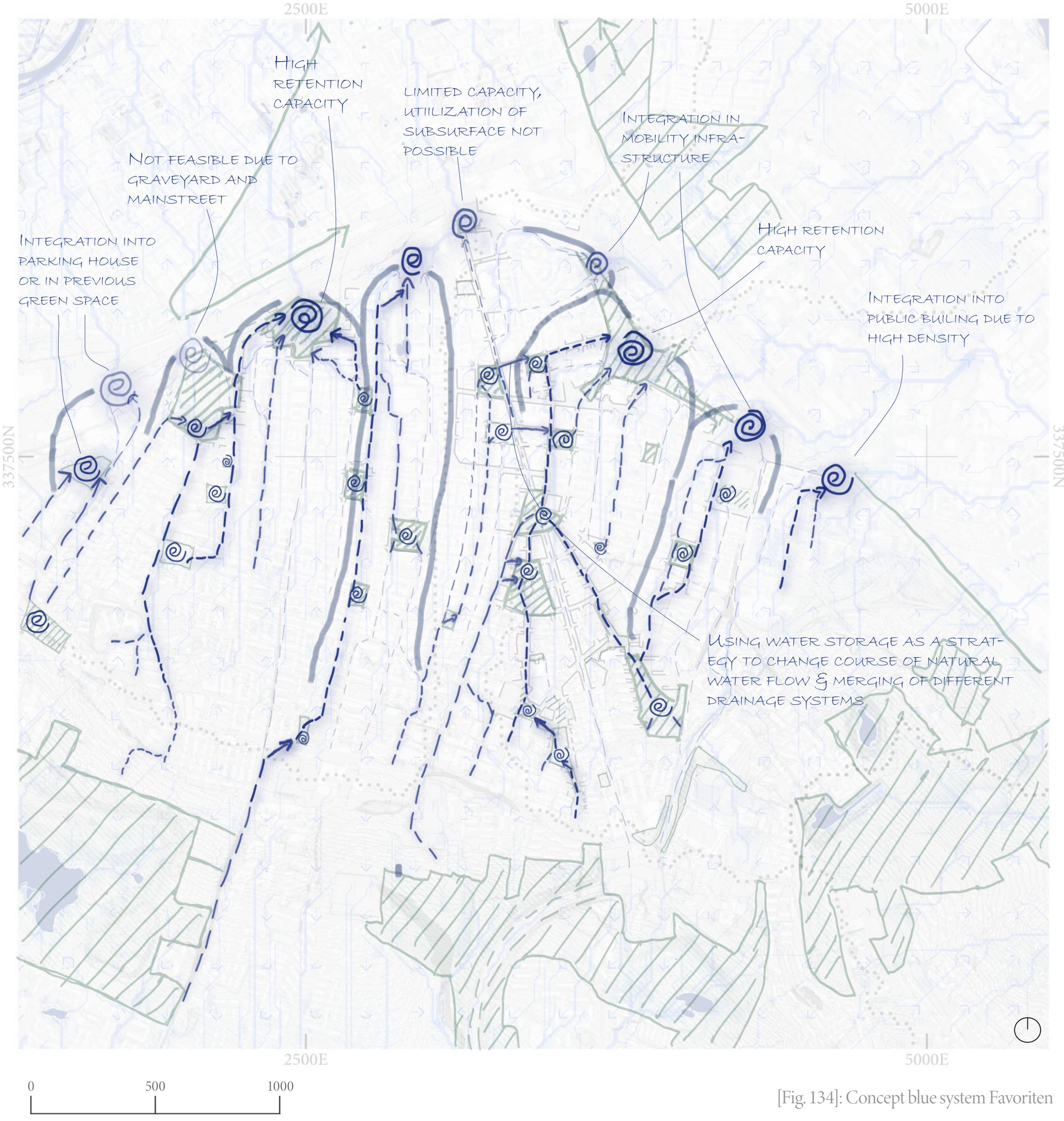
Main (final) retention areas

Retention areas

Main drainage network

Minor drainage network (possibly later added)

Storage for change of flow direction




[Fig. 134]: Concept blue system Favoriten

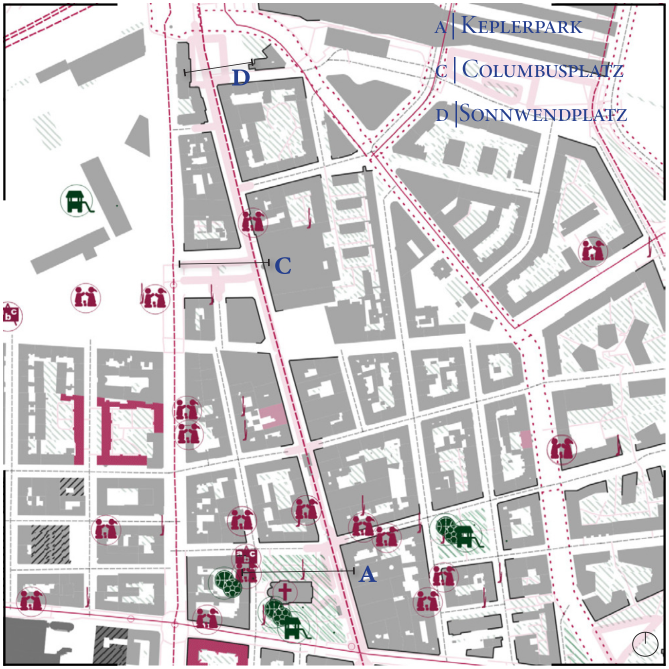
# Favoriten: The Social System

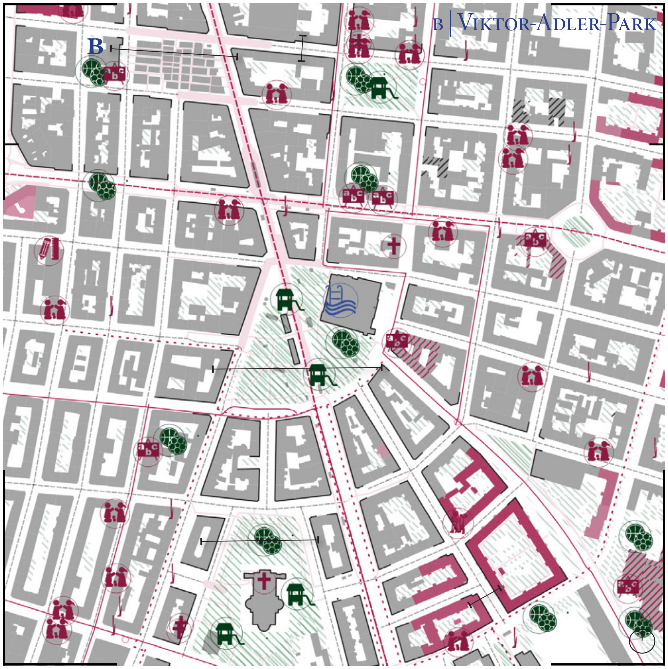
## Analysis

As previously mentioned Favoriten & in particular the Favoritenstraße as central area lacks public space with social amenities. In relation to the population density this area is heavily underdeveloped and qualitative public spaces are heavily crowded on warm days.

Further many social housing areas in the focus area provide green space, however, they are underdeveloped and dont provide qualities for social & communal activities as well as substantial ecosystem benefits.

However, communal amenities & benefits within qualitative green spaces in parks & squares can provide an access point for valuing & managing ecosystems and reconnecting to them. Connecting social facilities like schools, kindergardens & education centres as well as social housing areas with communal amenities & ecosystem benefits provides a potential strategy ecosystem stewardship.



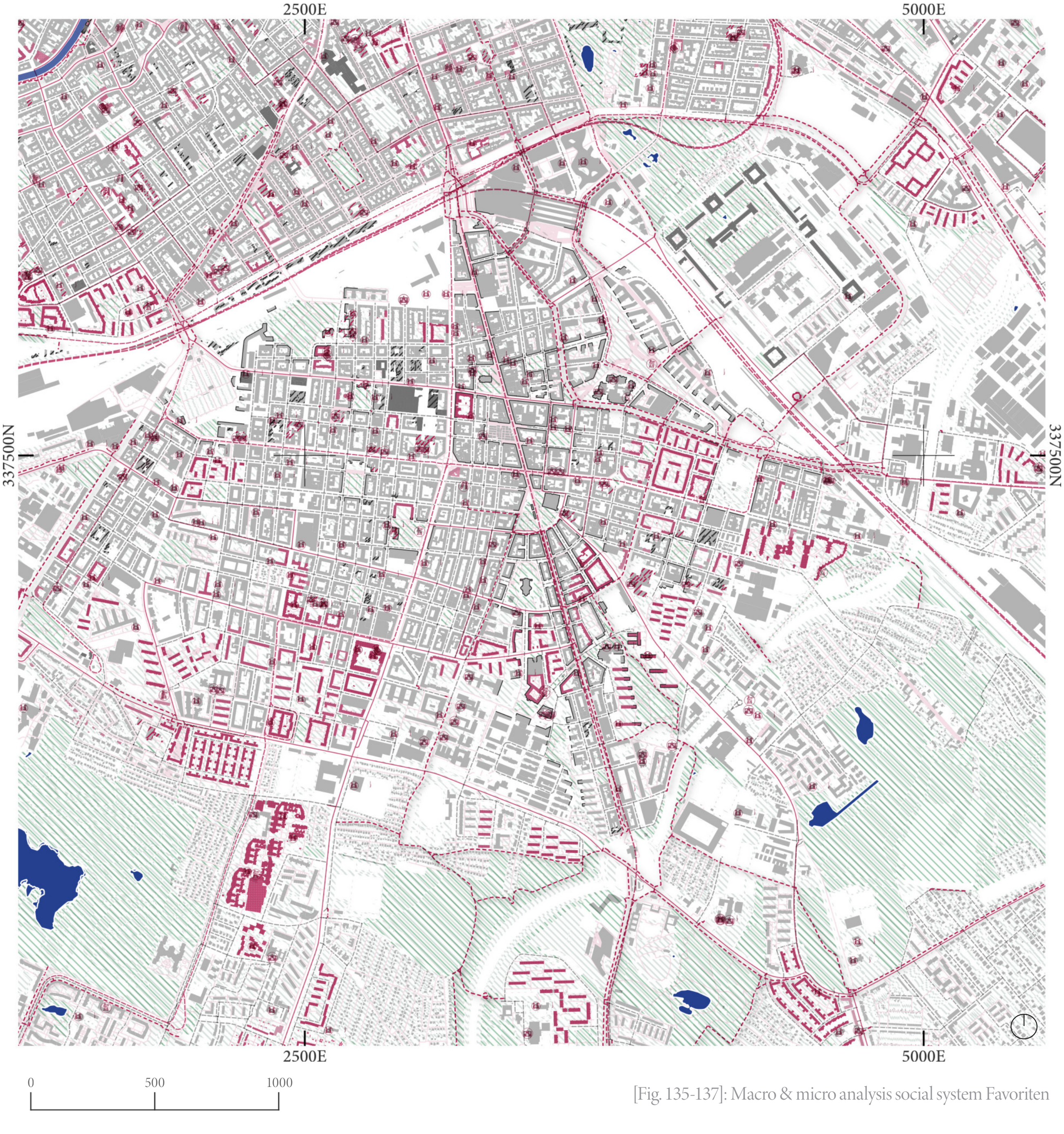

Legend

- Social housing (high to low amount of flats)
- Public social facilities
- Commercial facilities with public functions
- Public/ private administration
- Public/ private transport facilities
- Public park/ square
- Green areas
- Train/ Metro
- Tram
- Bus

Micro

- Swimming pools & baths
- Playground
- Sport facility
- School
- Education centre
- University
- Kindergarden
- Youth centre
- Library
- Cult (Religion)

0 50 100 m

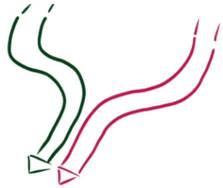



[Fig. 135-137]: Macro & micro analysis social system Favoriten

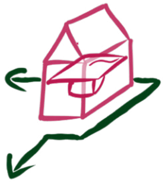
## Favoriten: The Social System

### Principles

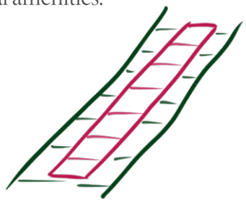
- Aligning ecosystem benefits with social benefits as social infrastructure



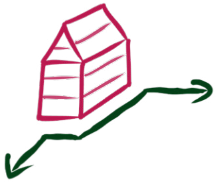
- Ecosystem as just instrument through prioritzing & connecting educational institutions



- Reallocating public space to function as both ecosystem and social infrastructure, connecting and offering communal amenities.



- Ecosystem as just instrument through prioritzing & connecting social housing neighbourhoods and upgrading living conditions



- Ecosystem maintenance & stewardship through local residents & social/ public institutions

Legend

Social network

Potential social network

Educational institutions

Social housing areas

Commercial (center) areas


[Fig. 138]: Concept social system Favoriten

## Green-blue-social grid for Favoriten

### Conclusion

The design concept for Favoriten outlines a green-blue-social grid aimed at creating, strengthening, and connecting existing green spaces, drainage systems, and social amenities. Priority is given to educational facilities, social housing, and central areas, such as the pedestrian zone Favoritenstraße, to address high usage pressure and enhance human benefits through spaces for interaction and communal activities.

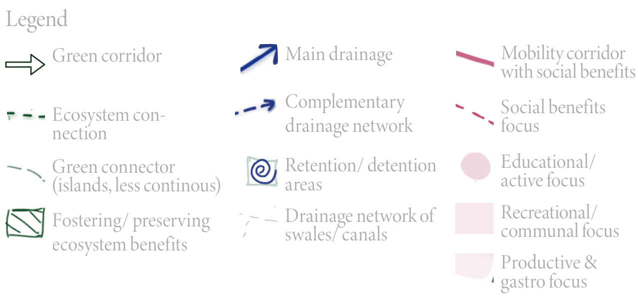
Central green corridors and direct connections between green patches are designed to enable natural & continuous biotope connections, often integrated with rainwater drainage systems. This natural configuration, facilitated by the area's topography and green space patterns, towards the extensive green areas along the railway in the north, enables water supply of vegetation and the usage of the extensive green areas as natural retention areas. This strengthens the areas as ecosystems in the form of wetlands, fostering flora and fauna and their movement towards northern biotopes.

However, the integration of canals for drainage is not prioritized in Favoriten, due to high density and challenging subsoil characteristics

The resulting network features clear systemic focal points while ensuring overlapping systemic values. Further design exploration will investigate the integration of this network and its associated benefits.



### Systemic focus




[Fig. 139]: Conclusive concept Favoriten

## A | KEPLERPARK

An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, displaying demands and focal systems.

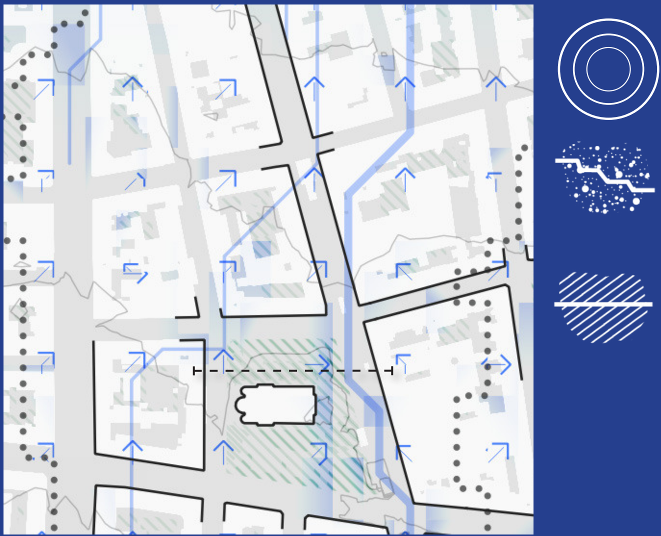
Subsequent pages illustrate the integrated principles within the transitioned & aspired climate-resilient urban landscape and showcase water characteristics and social benefits.

PATCH
- green park
- district center
- well frequented, public transport connection

CORRIDOR
- minor green corridor as pedestrian area

### THE PRESENT





PATCH
- terraced soil, allows infiltration
- accumulation possible

CORRIDOR
- sealed & closed accumulation
- minor slope

PATCH
- recreational area
- meeting/ gathering area
- district center
- school, kindergarden with playground


[Fig. 140]: Section present state

## A | Keplerpark

### Systemic focus

### Timeframe

**Breathing surface**

**Multifunctional infrastructure**

**Green corridor**

Stop sealing surface!

Tiles as entrance area

Green island with seating possibilities

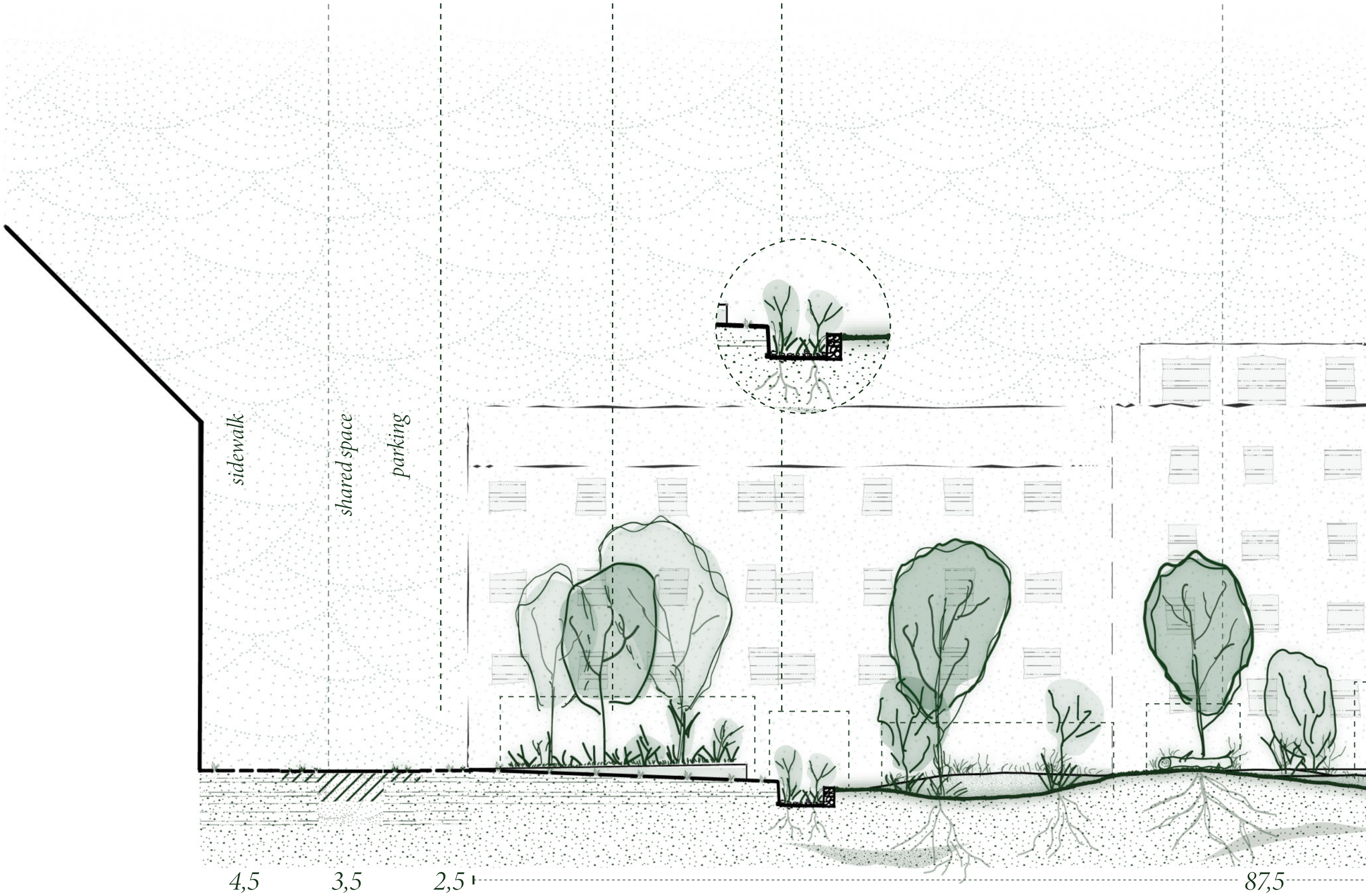
Swale as green corridor

Natural furniture

Channels water to flow into a swale. Entrance square situated between the park and the district center.

Canalized swale with semi-hard edge & vegetated gabions towards the park.

Space for waterstream landscape with green shores as g corridor to foste biodiversity



**Ecological urban patches**

Natural "playground"

Natural park landscape

Green arena

Lowered green areas offer spaces for seating and vegetation, serving as gathering spots and aiding in water collection.

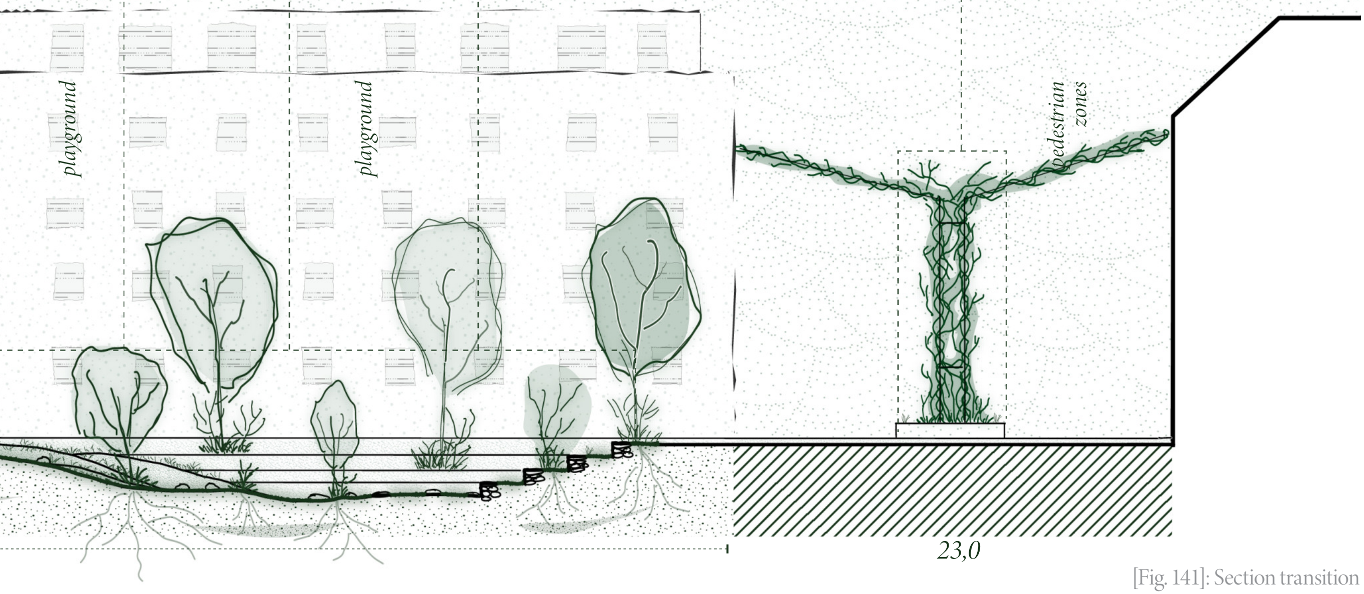
These areas contribute to a cooler and less noisy environment, providing a serene oasis in a highly frequented area. Additionally, they facilitate social control, and the topography is strategically utilized for integrating furniture, enhancing both functionality and aesthetics.

**Linear ecosystem**

Unearthed tree

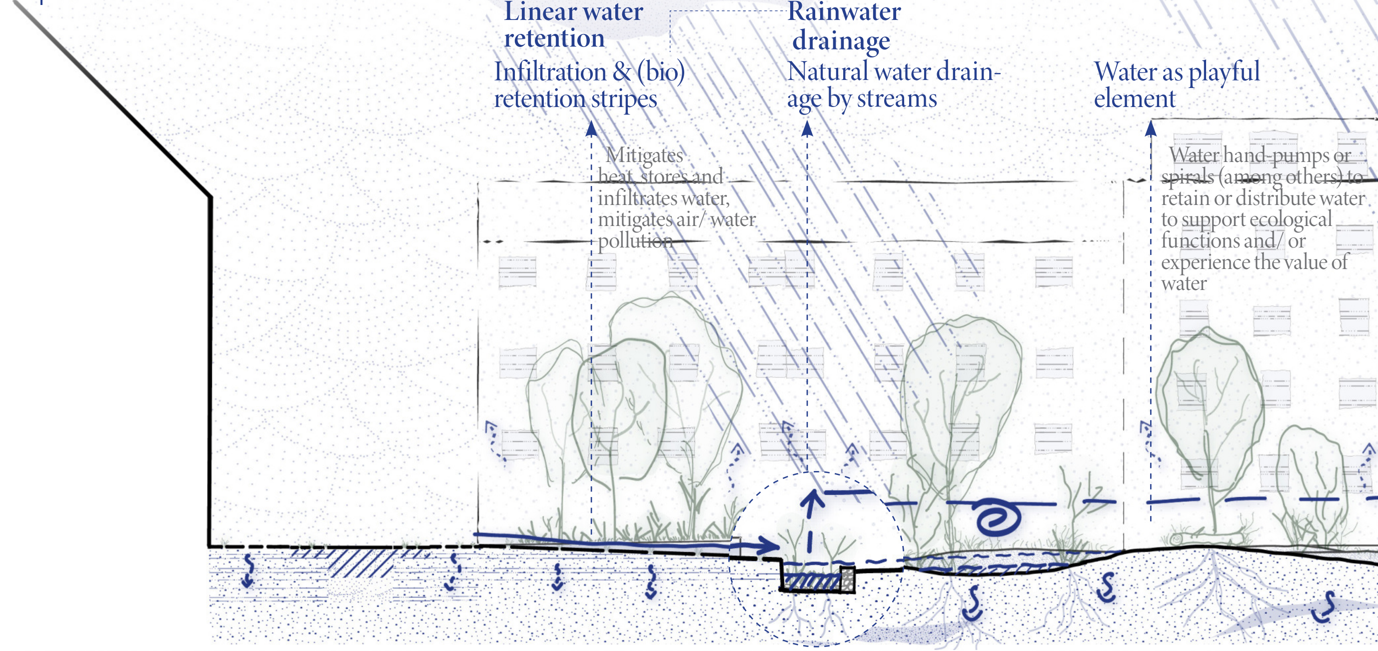
Climbing plants ascend a metal structure, entwining with wires affixed to nearby facades.

This creates a verdant link between buildings, establishing widespread shade. This approach doesn't necessitate deep soil for root growth, it can grow in planting boxes placed central in the Favoritenstraße.

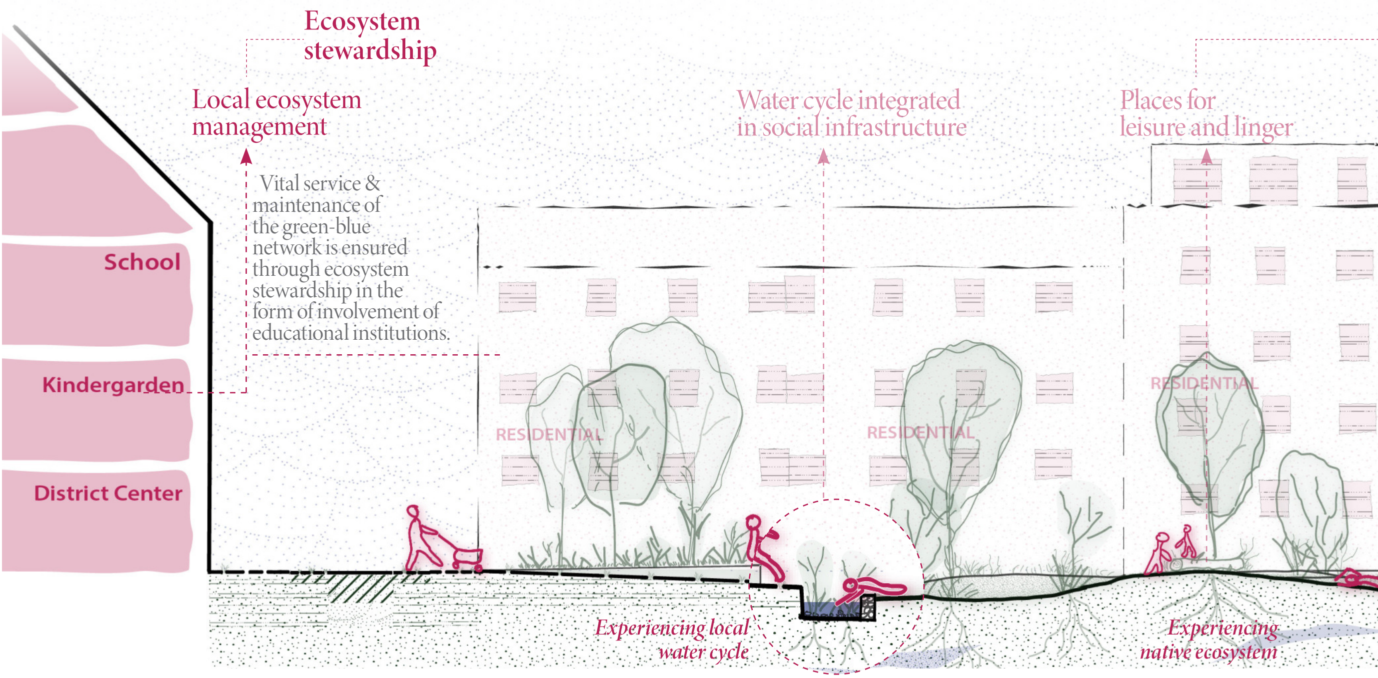


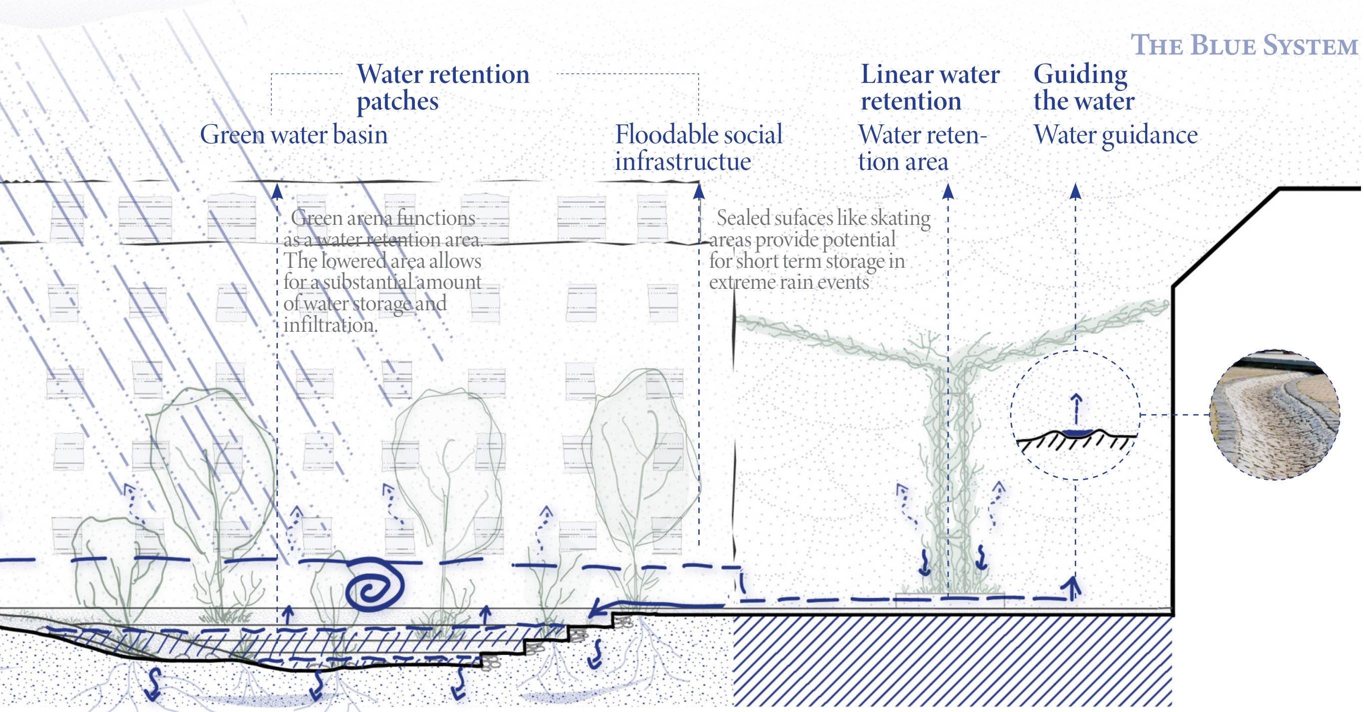

[Fig. 141]: Section transition

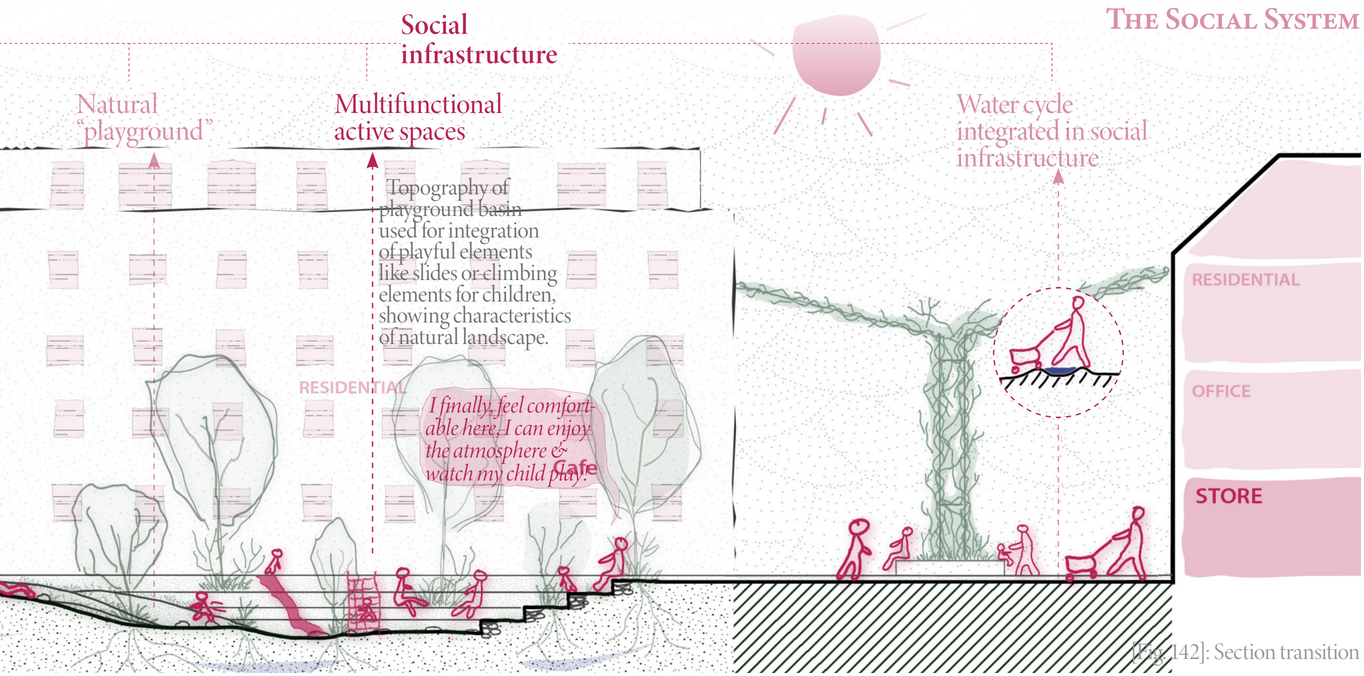
## A | Keplerpark








[Fig. 142]: Section transition

## B | Viktor-Adler-Park

An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, displaying demands and focal systems.

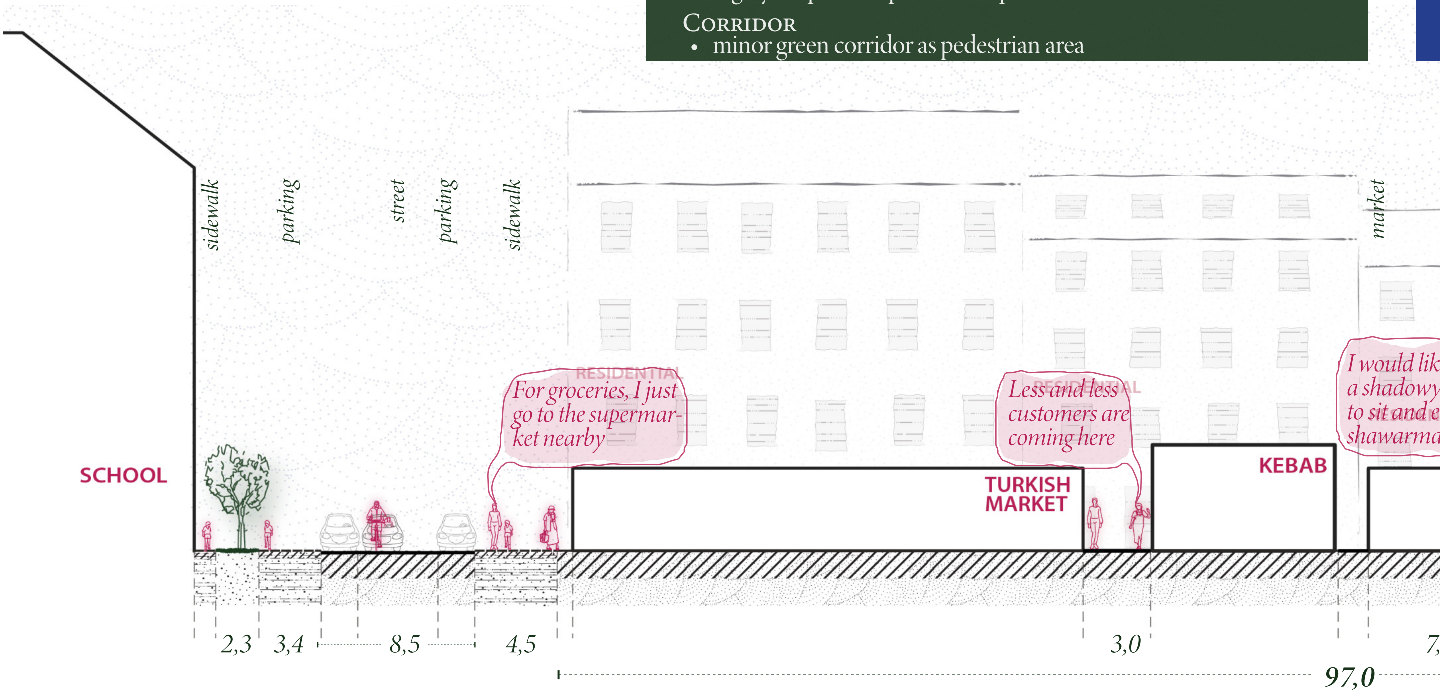
Subsequent pages illustrate the integrated principles within the transitioned & aspired climate-resilient urban landscape and showcase water characteristics and social benefits.

**Patch**
- very dense & no greenery
- little quality of stay
- highly frequented, public transport connection

**Corridor**
- minor green corridor as pedestrian area

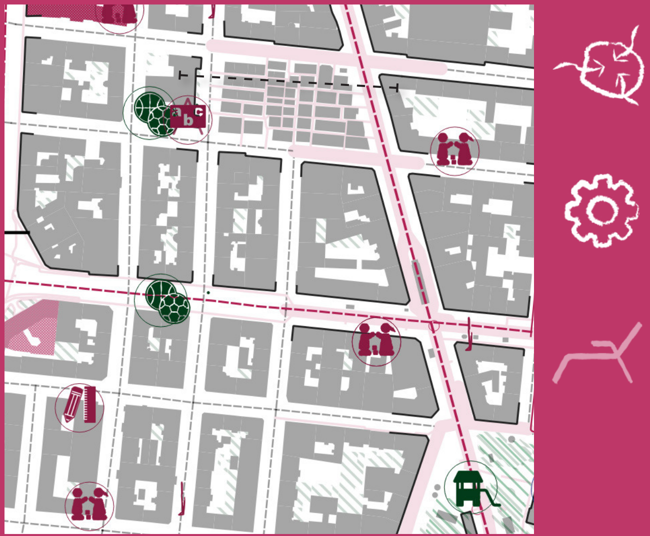
### The Present



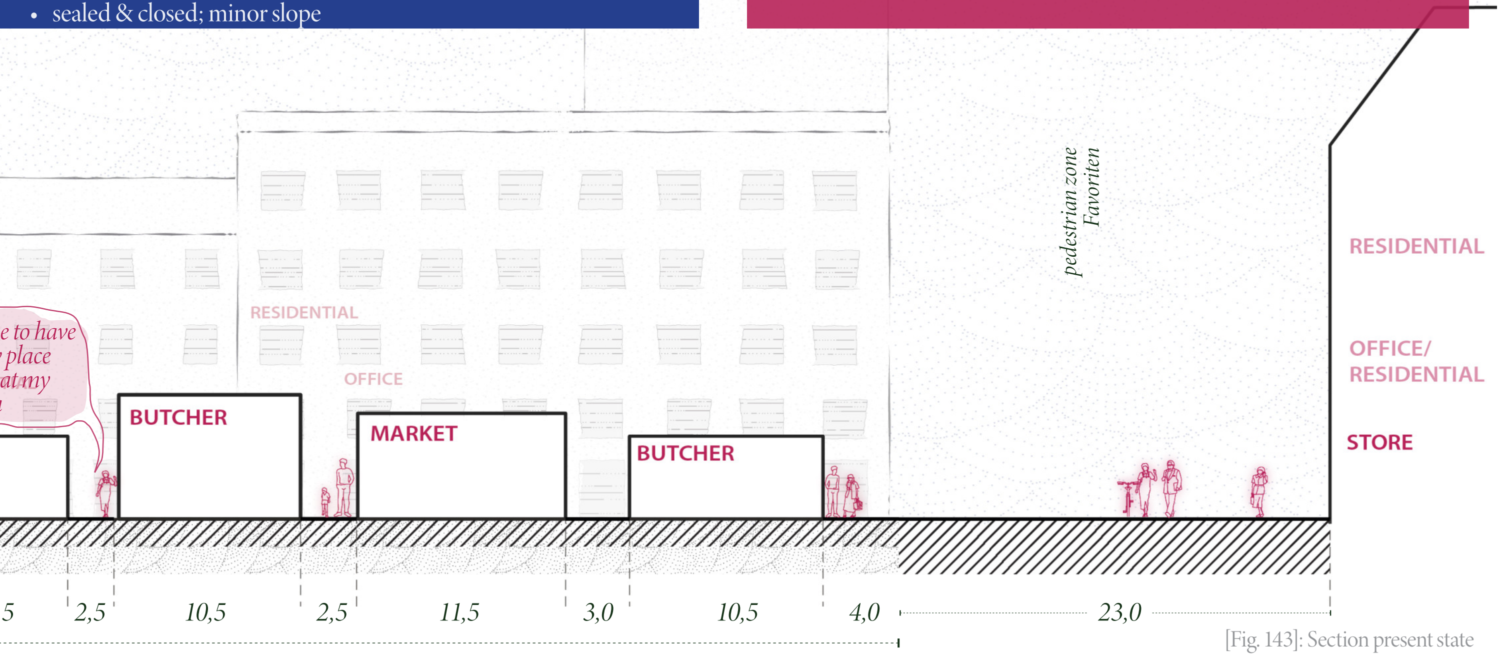


Patch
- accumulation possible
- sealed & closed
- unsealing limited possible (terraced soil underneath)

Corridor
- sealed & closed; minor slope



Patch
- commercial usage
- meeting/ gathering area
- commercial district center
- cultural initiatives




[Fig. 143]: Section present state

## B | Viktor-Adler-Park

Systemic focus

Timeframe

**Linear ecosystem**

Retention stripes

Vegetated canal

Canal with vegetated gabions guides, stores and provides water for sourrounding ecosystem.

Green roofs

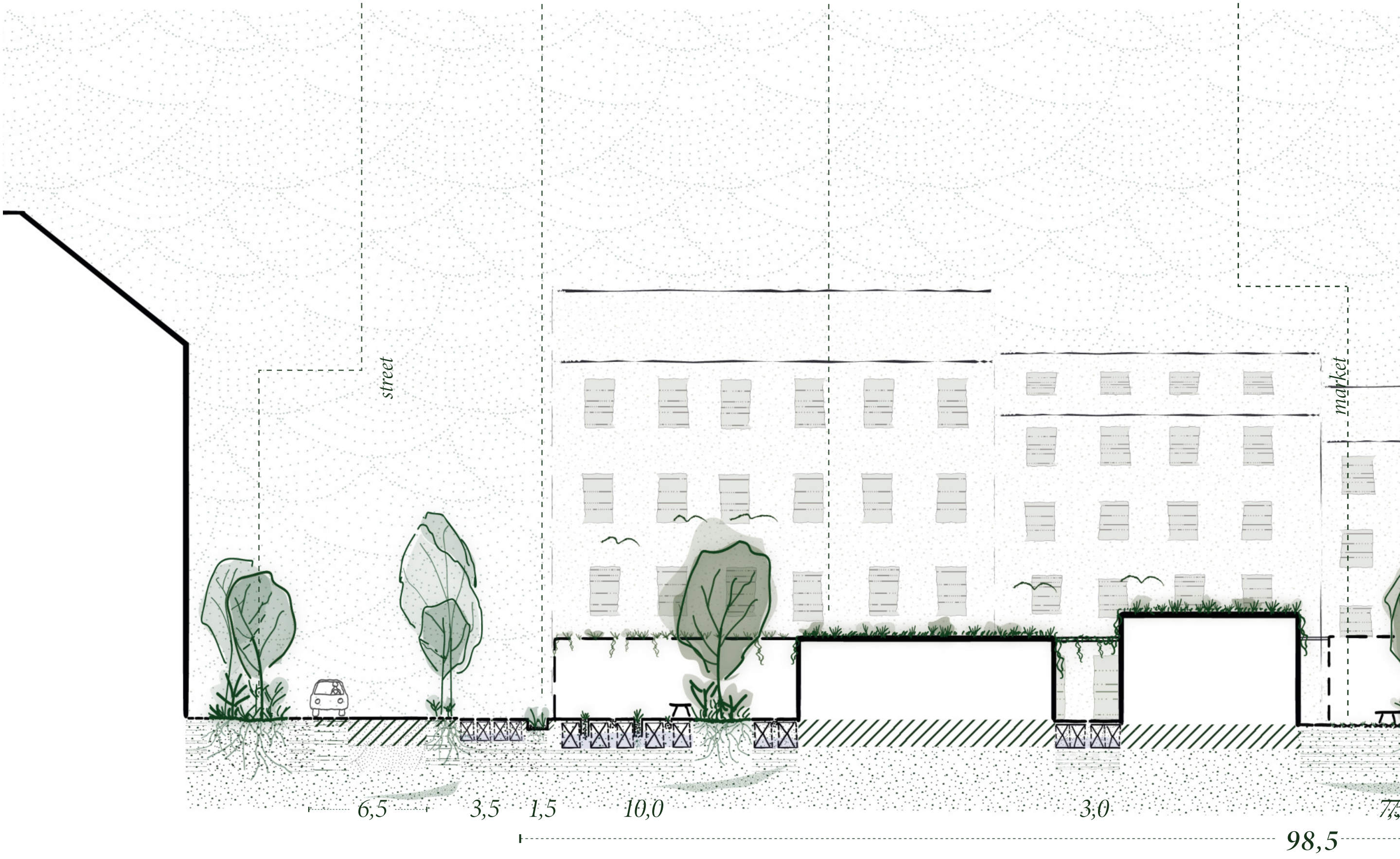
Climbing plants growing along a metal structure, and wires, which are attached to facades in proximity. They provide a green connection between buildings and shadow, without the need for sub-soil usage..

**Breathing surface**

Open surface!

Allowing the soil and the ecosystem breathe by providi open surfaces like grass pavers or gravel.





**Squares as green nodes**

**Green islands**

For dense urban environments ecosystem connection & benefits can be provided by integrating pocket parks, compact green areas for breaks for human and non-human actors

**Ecosystem bridges**

Providing a frame for plants to climb between two buildings by metal frame or wire to connect green roofs . This provides ecosystem connectivity and shadow to mitigate heat.

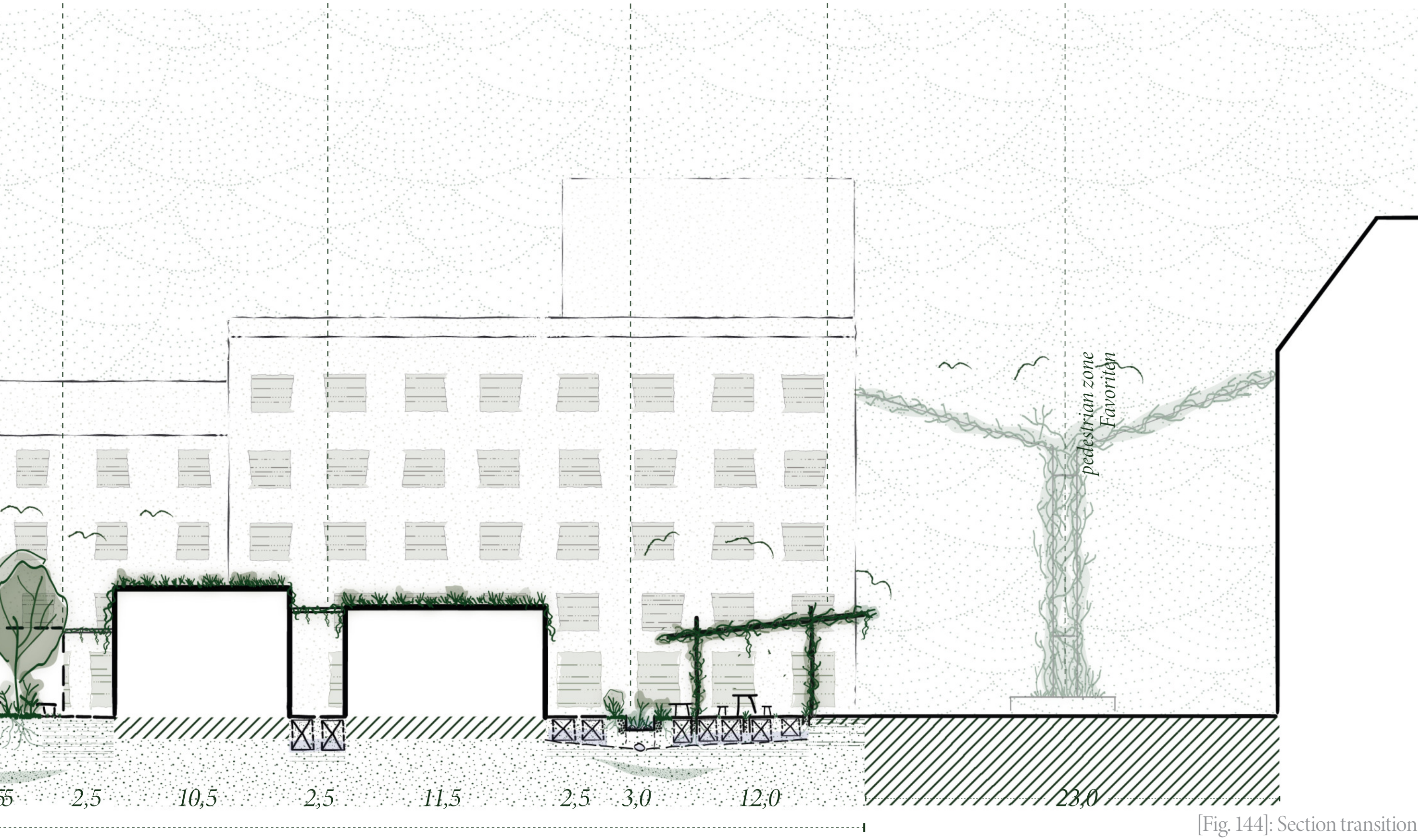
**Bio planter**

One side with vertical wall, and one slightly graded side slope via gabions, allowing vegetation and irrigation.

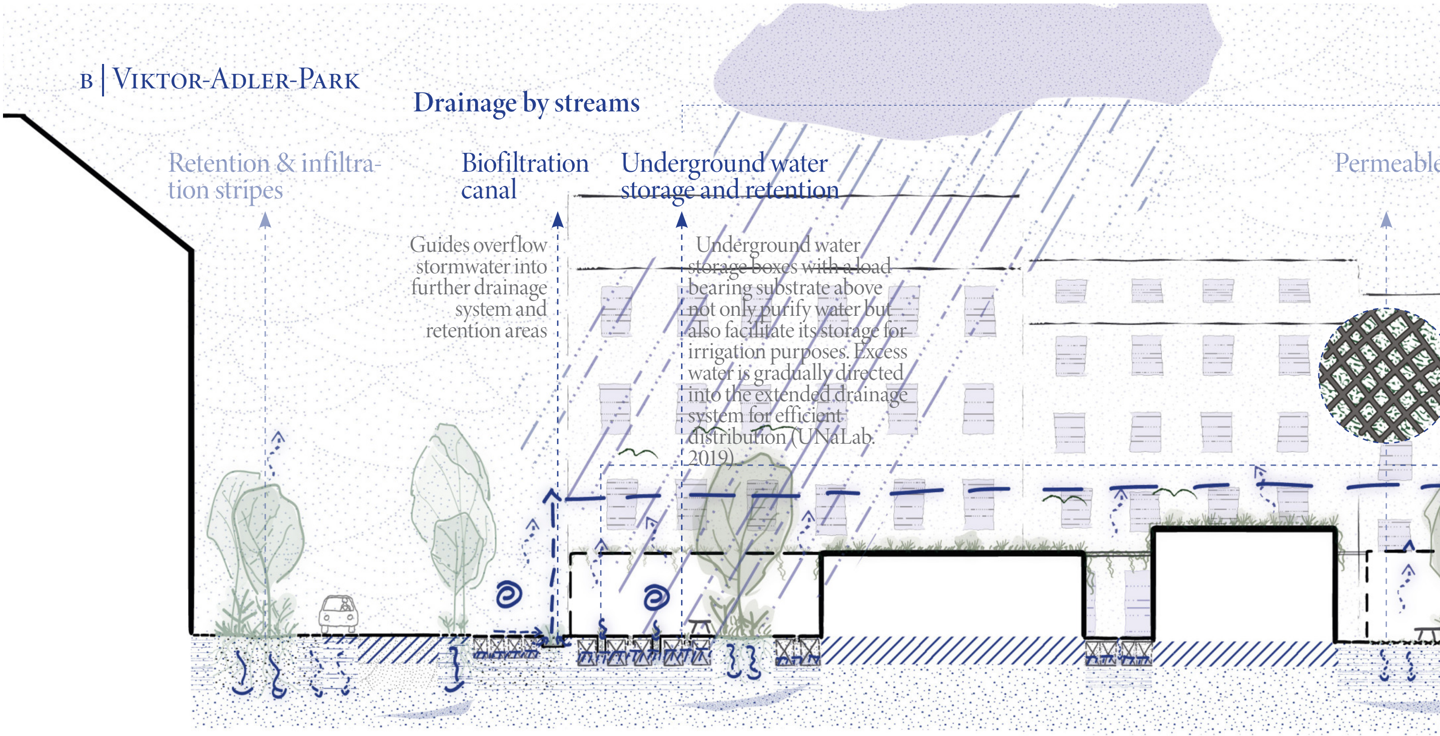
**Green pergola**

Pergola provides frame for plants to climb, creating a shaded confinded space.

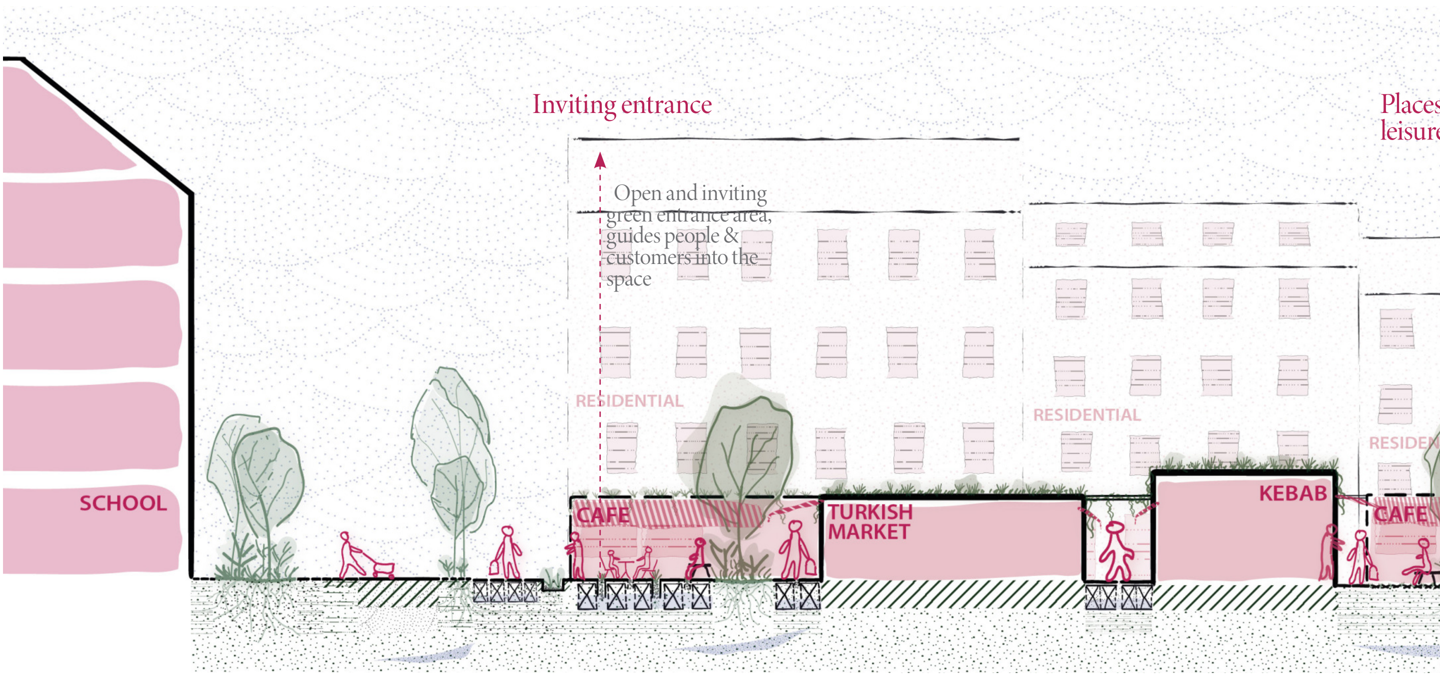
**Unearthed tree**

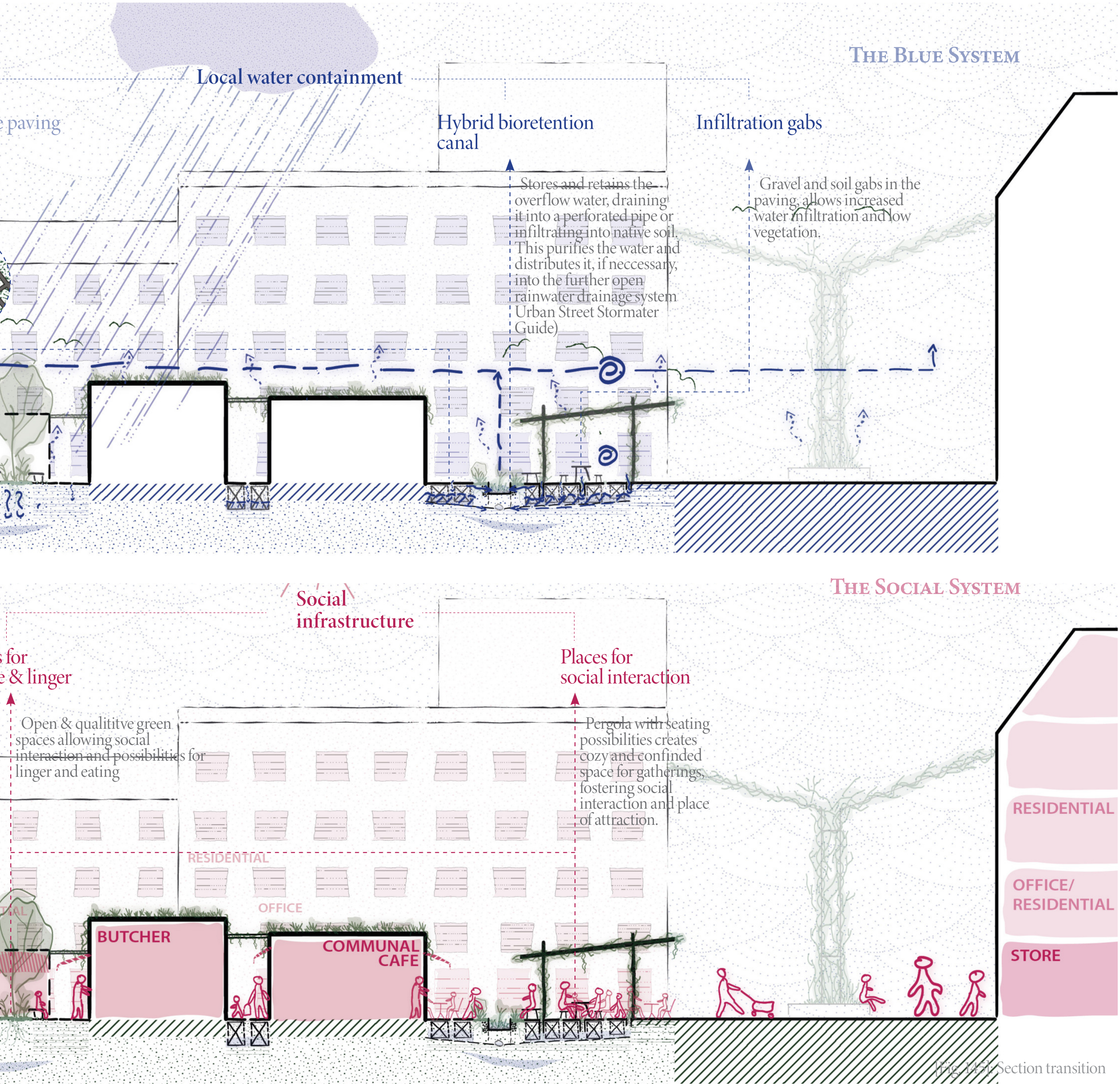



[Fig. 144]: Section transition


B | Viktor-Adler-Park
Drainage by streams
Retention & infiltra-tion stripes
Biofiltration canal
Underground water storage and retention
Permeable
Guides overflow stormwater into further drainage system and retention areas
Underground water storage boxes with a load bearing substrate above not only purify water but also facilitate its storage for irrigation purposes. Excess water is gradually directed into the extended drainage system for efficient distribution (UNaLab, 2019)




Inviting entrance
Places
leisure
Open and inviting green entrance area, guides people & customers into the space
RESIDENTIAL
RESIDENTIAL
SCHOOL
CAFE
TURKISH MARKET
KEBAB
CAFE




[Fig. 145]: Section transition

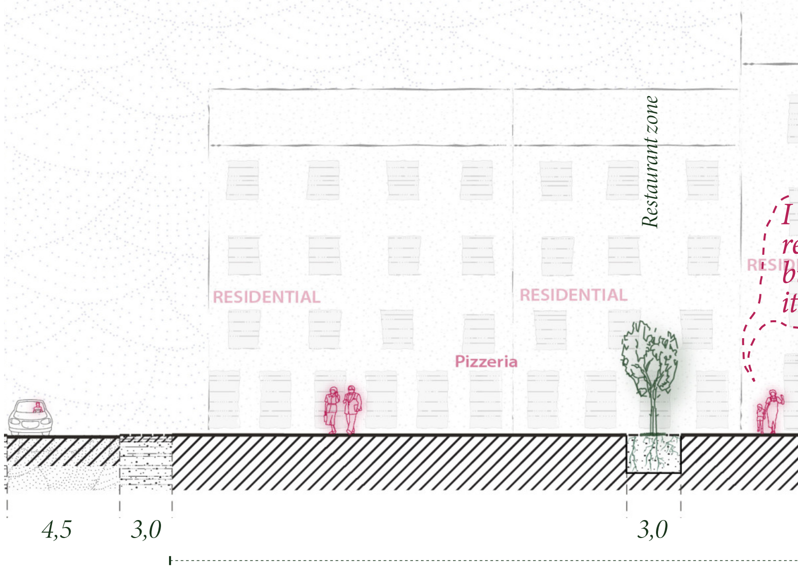
## c | Columbusplatz

An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, showcasing demands and focal systems.

Patch
- green park
- district center
- well frequented, public transport connection

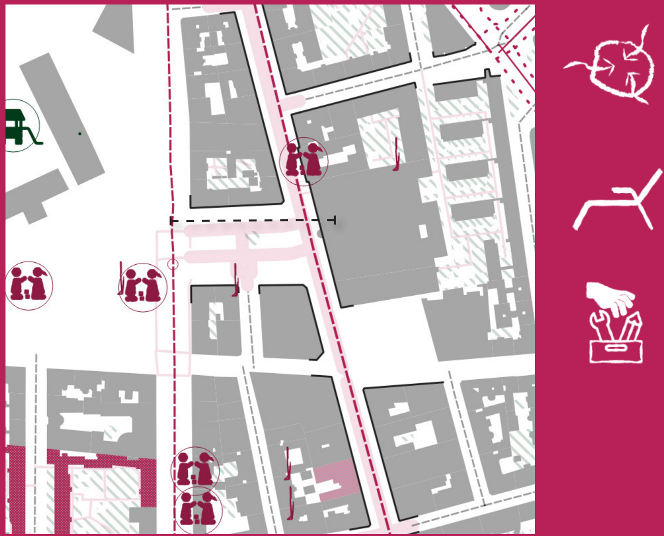
Corridor
- minor green corridor as pedestrian area

### The Present



Patch
- terraced soil, allows infiltration
- accumulation possible

Corridor
- sealed & closed accumulation
- minor slope



Patch
- recreational area
- meeting/ gathering area
- district center
- school, kindergarden with playground



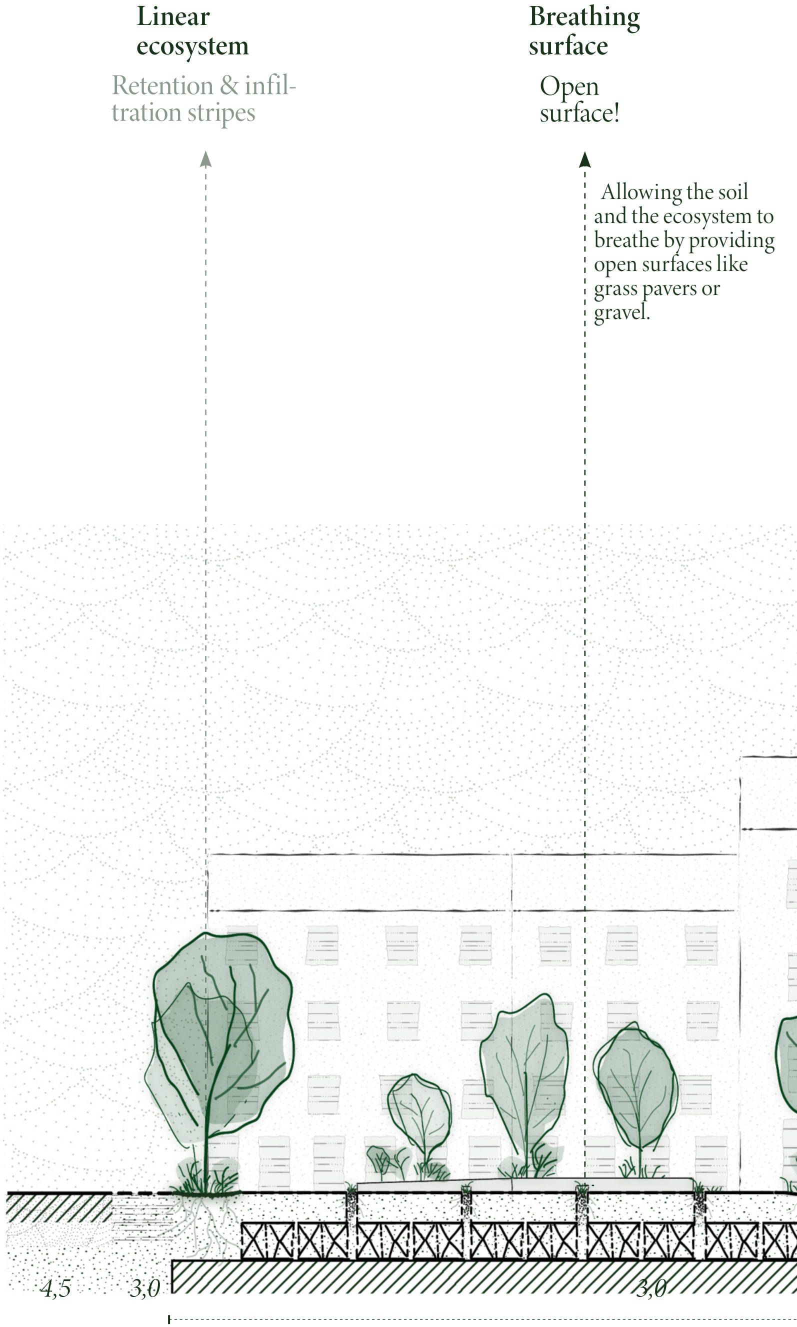

[Fig. 146]: Section present state

## c | Columbusplatz

Systemic focus

Timeframe

This illustrates the systemic focus & the integrated principles within the transitioned & aspired climate-resilient urban landscape.



**Ecological urban patches**

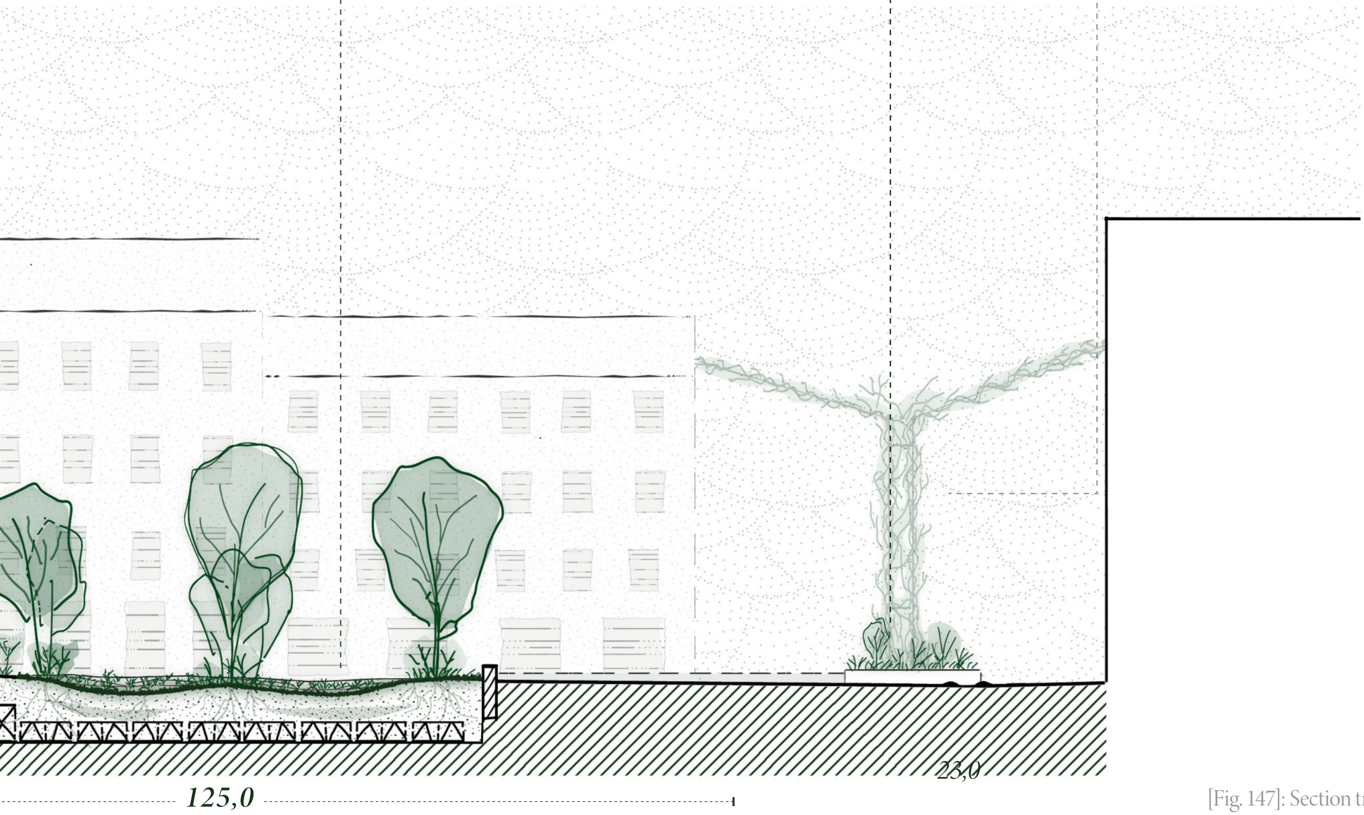
Continous green trench

**Linear ecosystem**

Biofilter as green island

Unearthed tree

Continous green trench enables ecosystem connectivivty and natural water distribution.

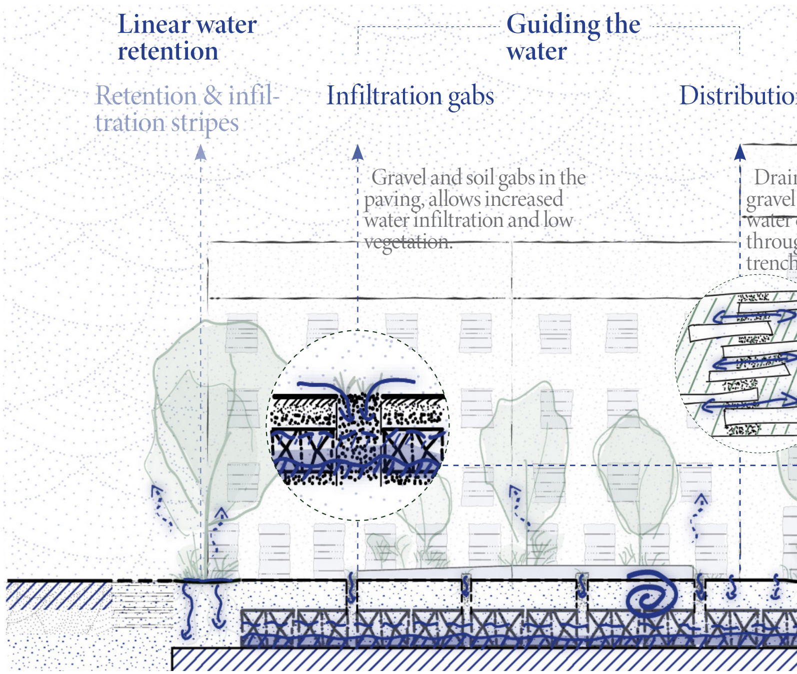


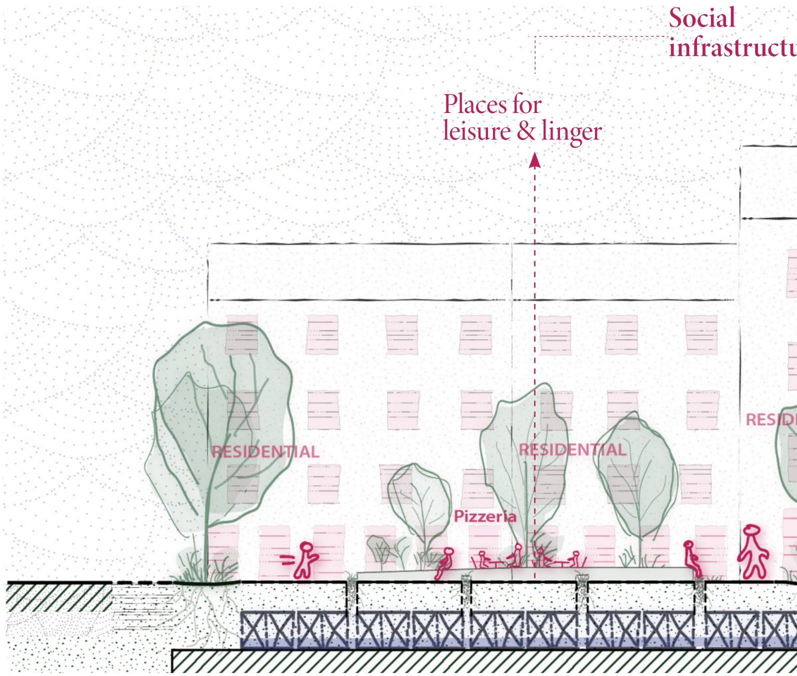

[Fig. 147]: Section transition

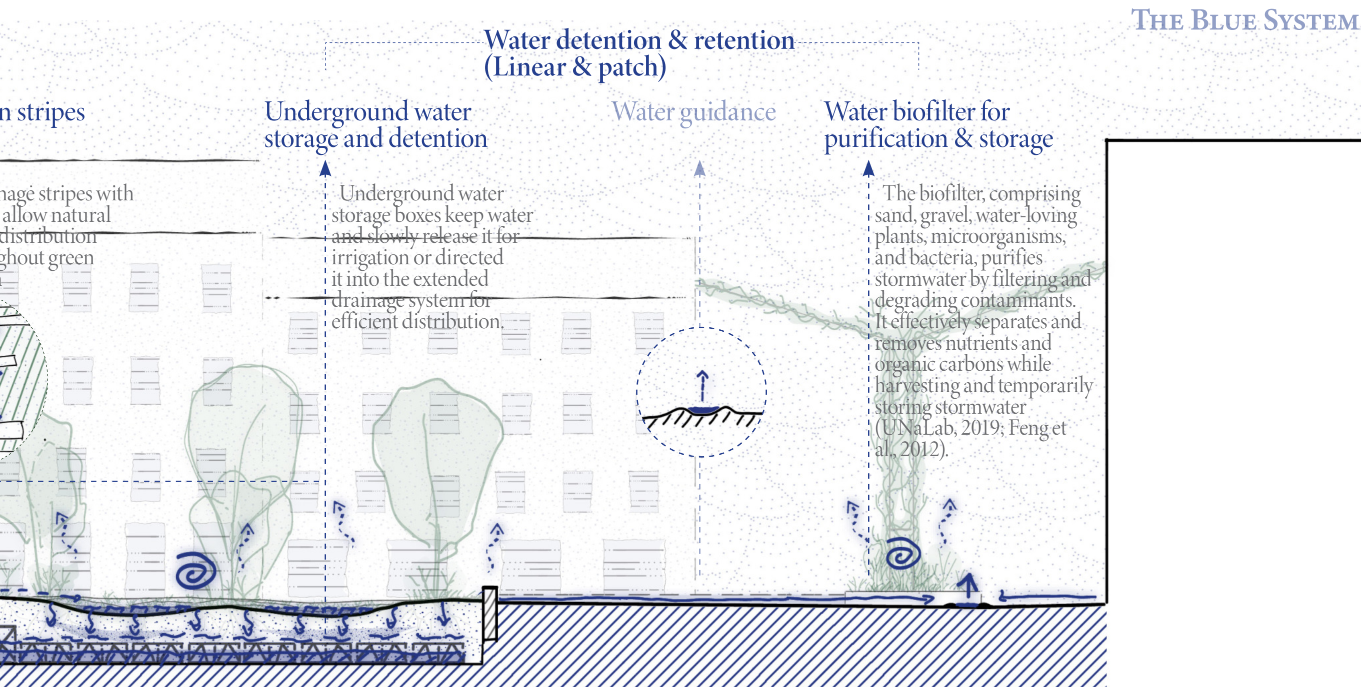
## c | Columbusplatz

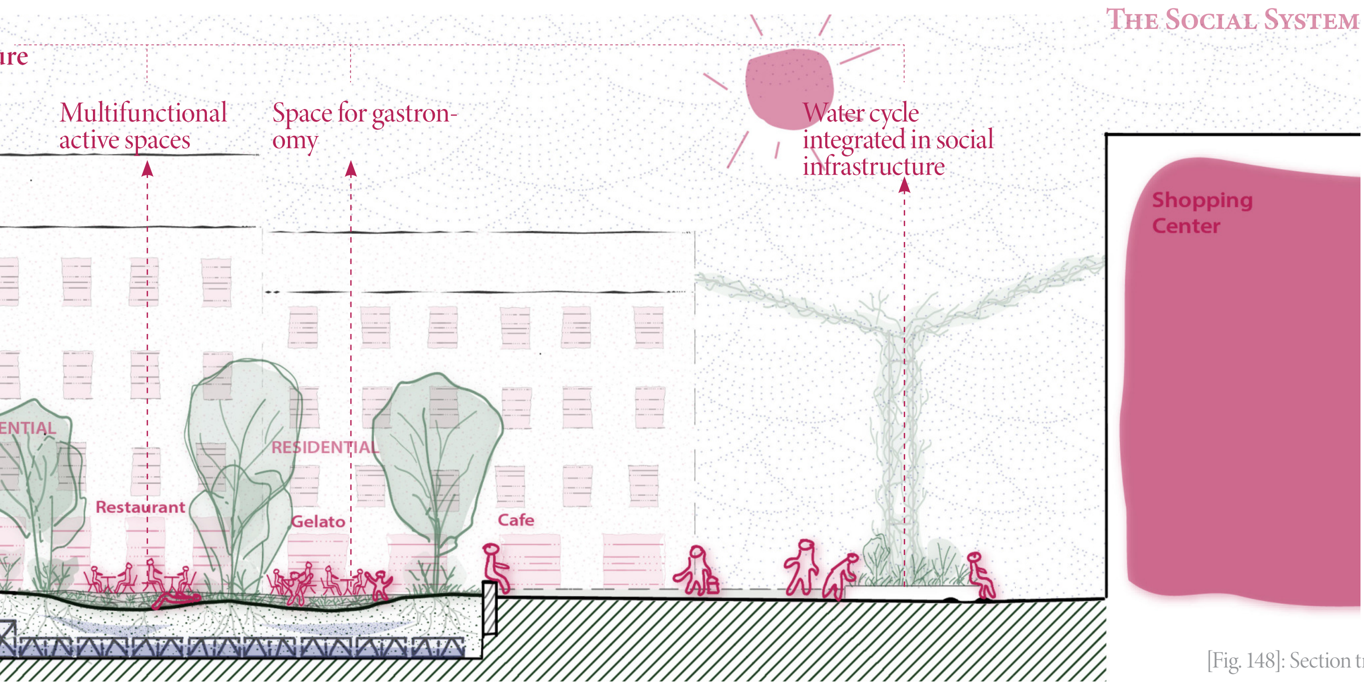
The integrated principles within the transitioned urban landscape are illustrated, showcasing water characteristics and social benefits.







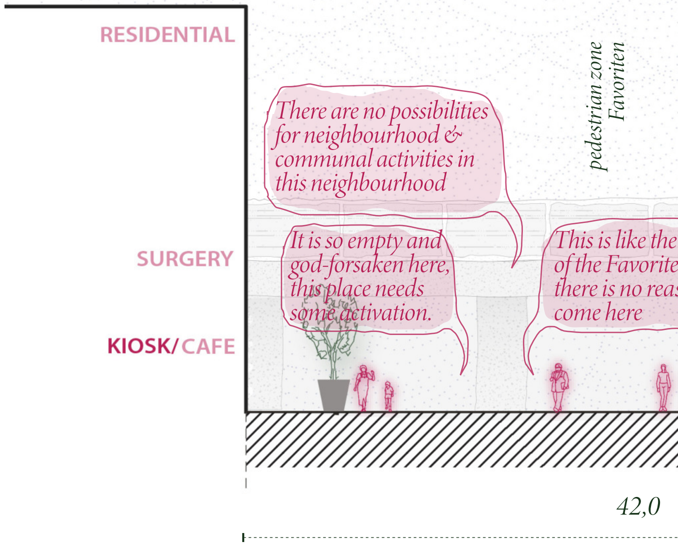

[Fig. 148]: Section transition

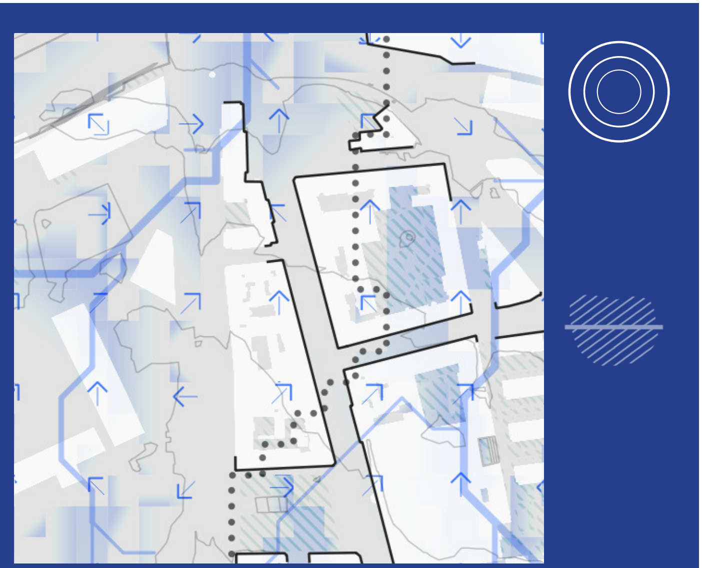
## D | Sonnwendplatz

An analysis and systematization of urban, landscape, and social characteristics are presented in the specific focus area, showcasing demands and focal systems.

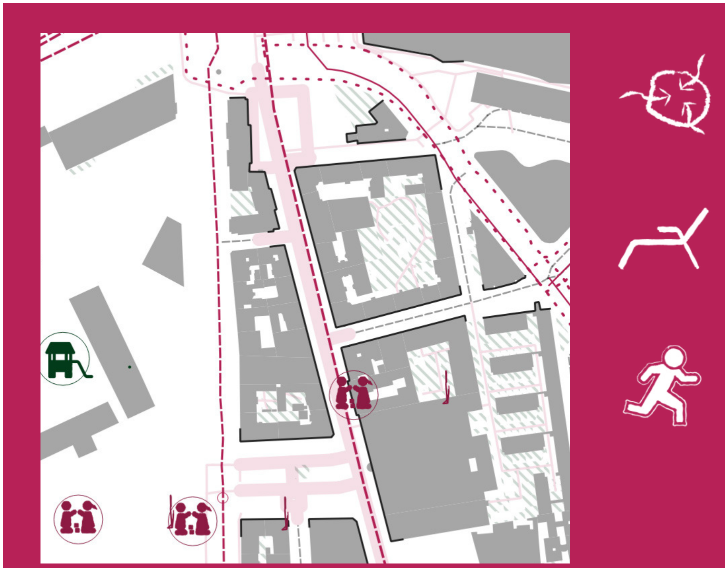
Patch
- little to no greenery
- wide space
- little frequented, no public space connection

### The Present



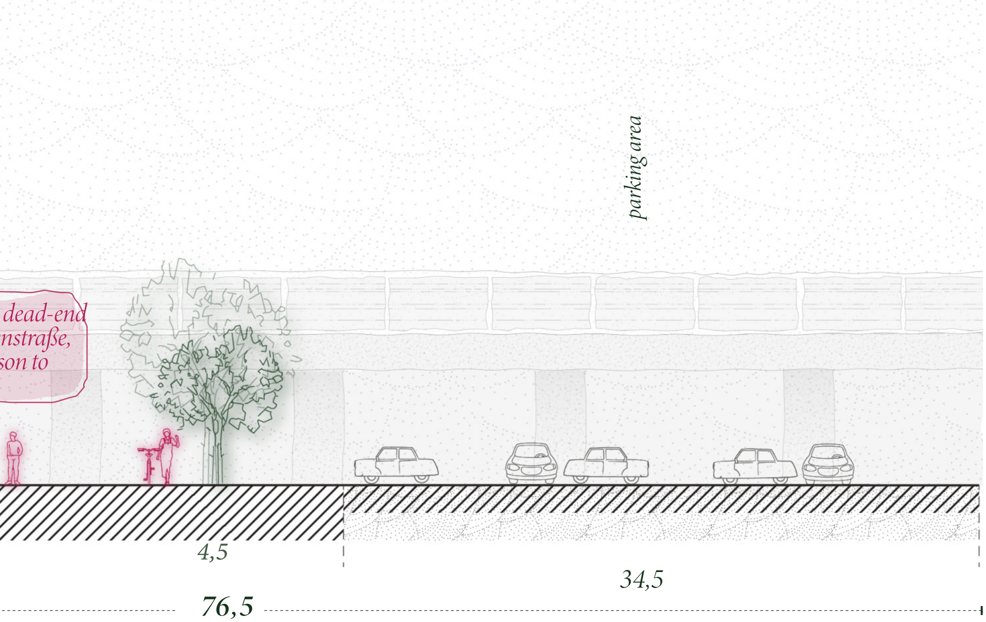


Patch
- accumulation possible
- sealed & closed
- sub-surface usage not possible



Patch
- potential meeting/ gathering area
- space & need for communal/ neighbourhood activities






[Fig. 149]: Section present state

## D | Sonnwendplatz

Systemic focus

Timeframe

This illustrates the systemic focus & the integrated principles within the transitioned & aspired climate-resilient urban landscape.

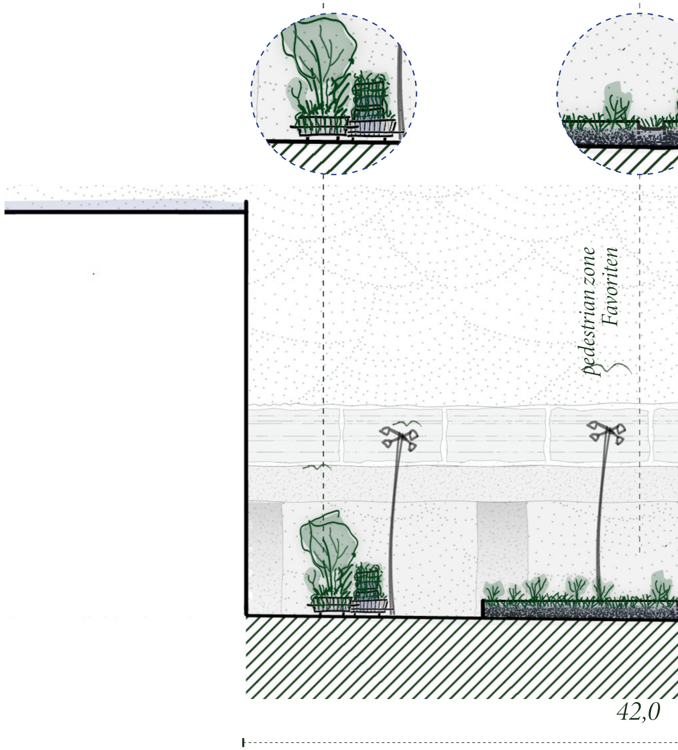
Urban spac
(Linear & p

Portable eco-furniture

Biofilter as g
island

Tree furniture consists of a tree, accompanied by a water tower.

Portable tree furniture is a compact ecosystem growing in a container, accompanied by a water tower. It not only offers ecological benefits but also serves as seating furniture. The self-sustaining furniture operates independently of urban infrastructure.



**ce as ecosystem
patch)**

green Green pergola

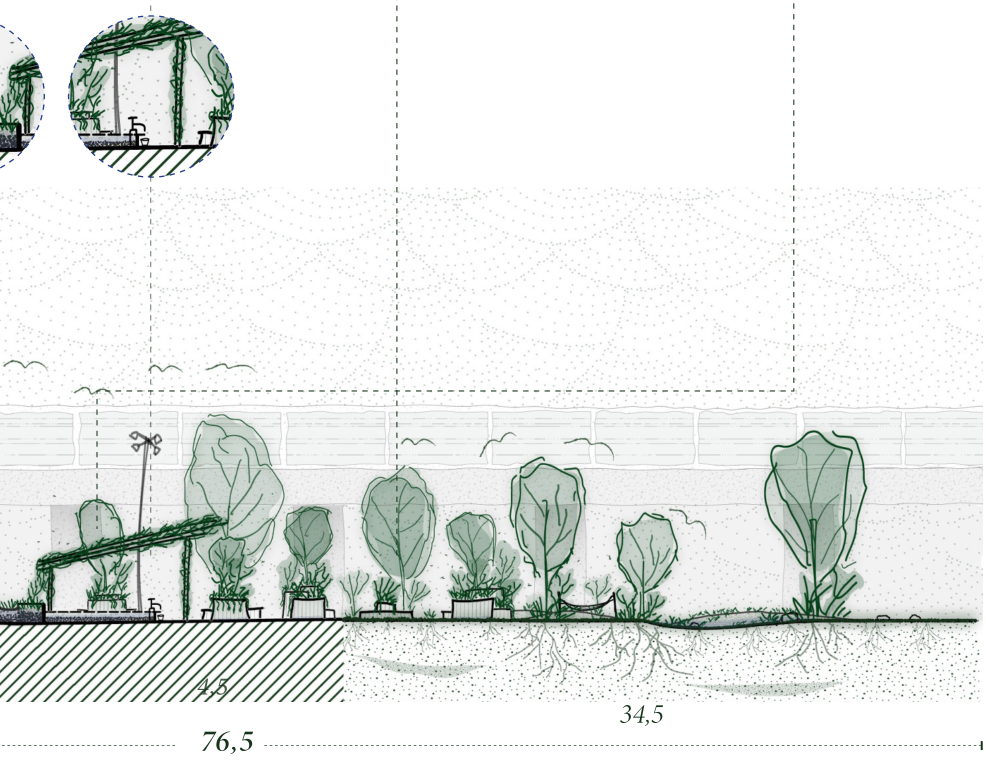
Urban gardens

Mobile green
living room

Space for urban gardening to provide greenerey and ecosystem connection.

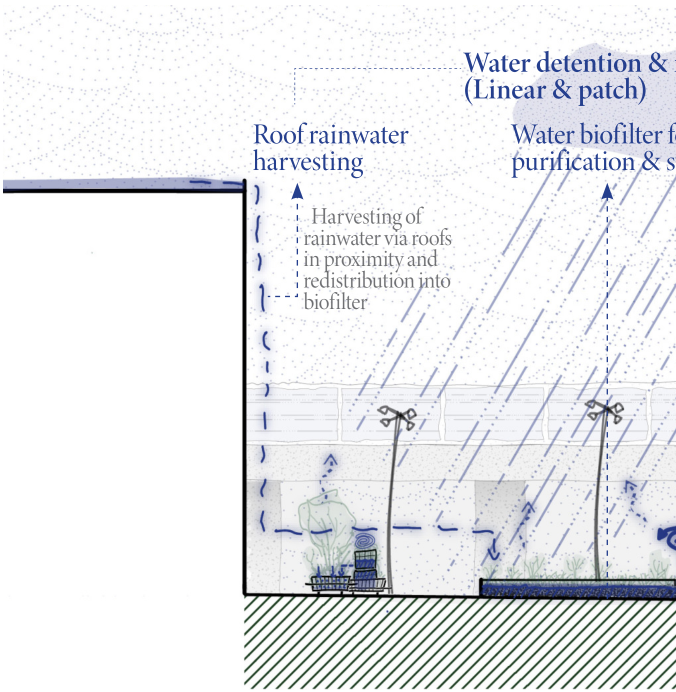
The usage of planting pots, raised planting beds and self-made urban furniture allows to integrate green infrastructure within a sealed surface and provides ecosystem benefits for residents and other species.

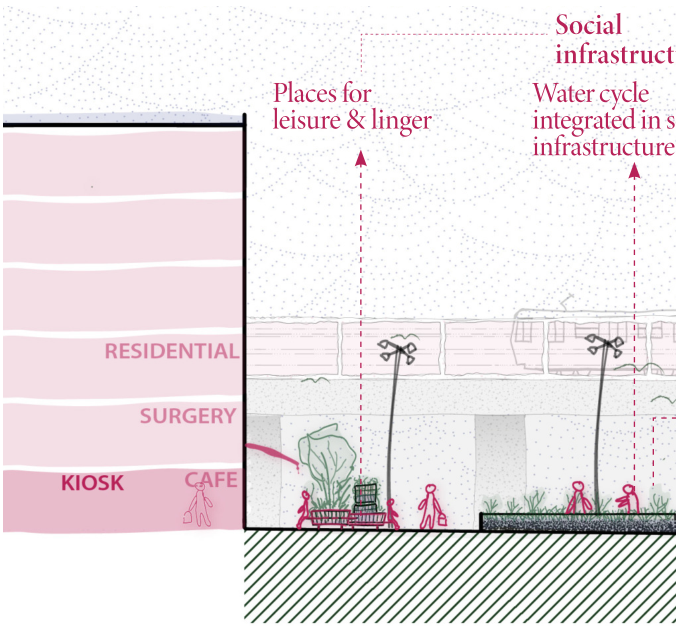
Movable platform with benches, green walls and a shaded roof, incorporating a water tank. The construction can be effortlessly relocated using vans.



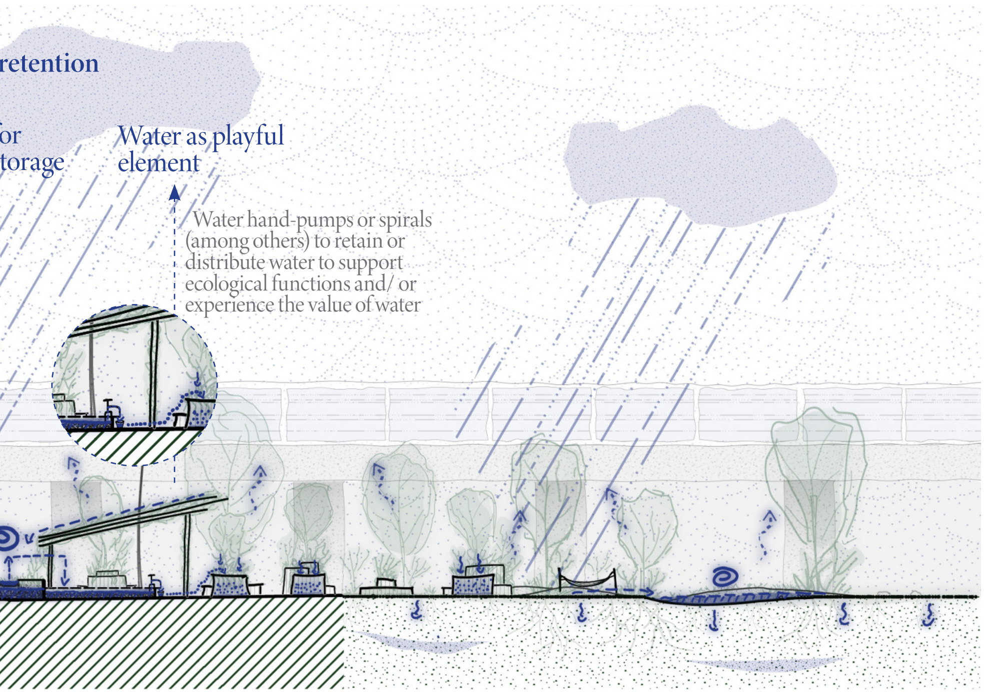

[Fig. 150]: Section transition

The integrated principles within the transitioned urban landscape are illustrated, showcasing water characteristics and social benefits.

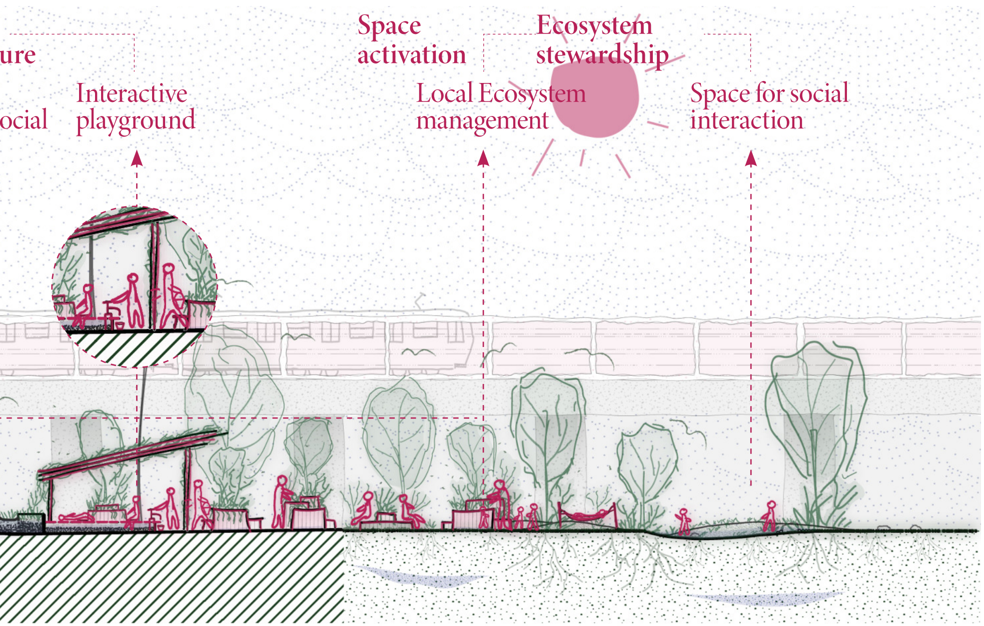


## The Blue System




## The Social System




[Fig. 151]: Section transition

# 5. Climate-resilient a

## 5.1 Principles as toolbox for

## 5.2 Design Principles as elem
## a wider system

# SSEMBLAGE OF VIENNA

## VIENNA

## ENTS OF

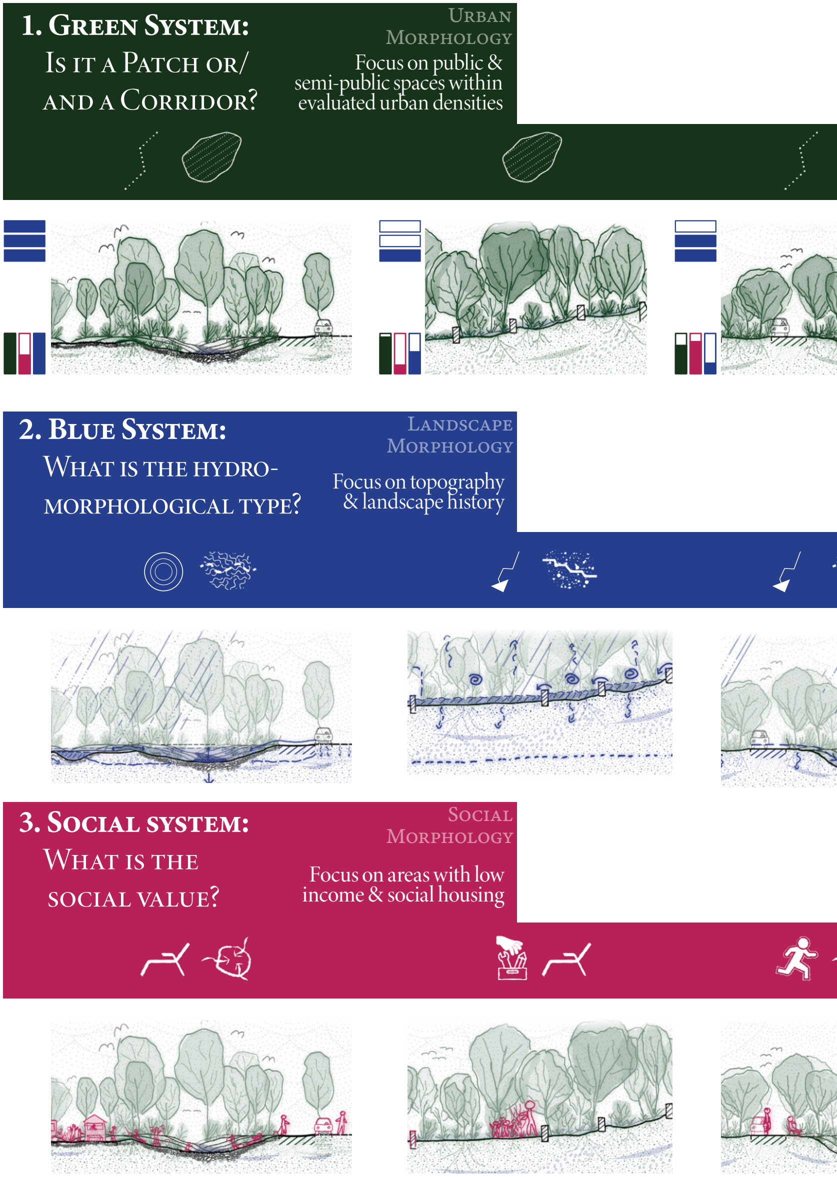
This chapter presents potential outcomes of Vienna's climate-resilient transition by evaluating and assembling different design principles and elements. It highlights how an exemplary public spaces can be utilized and their condition in different weather conditions.

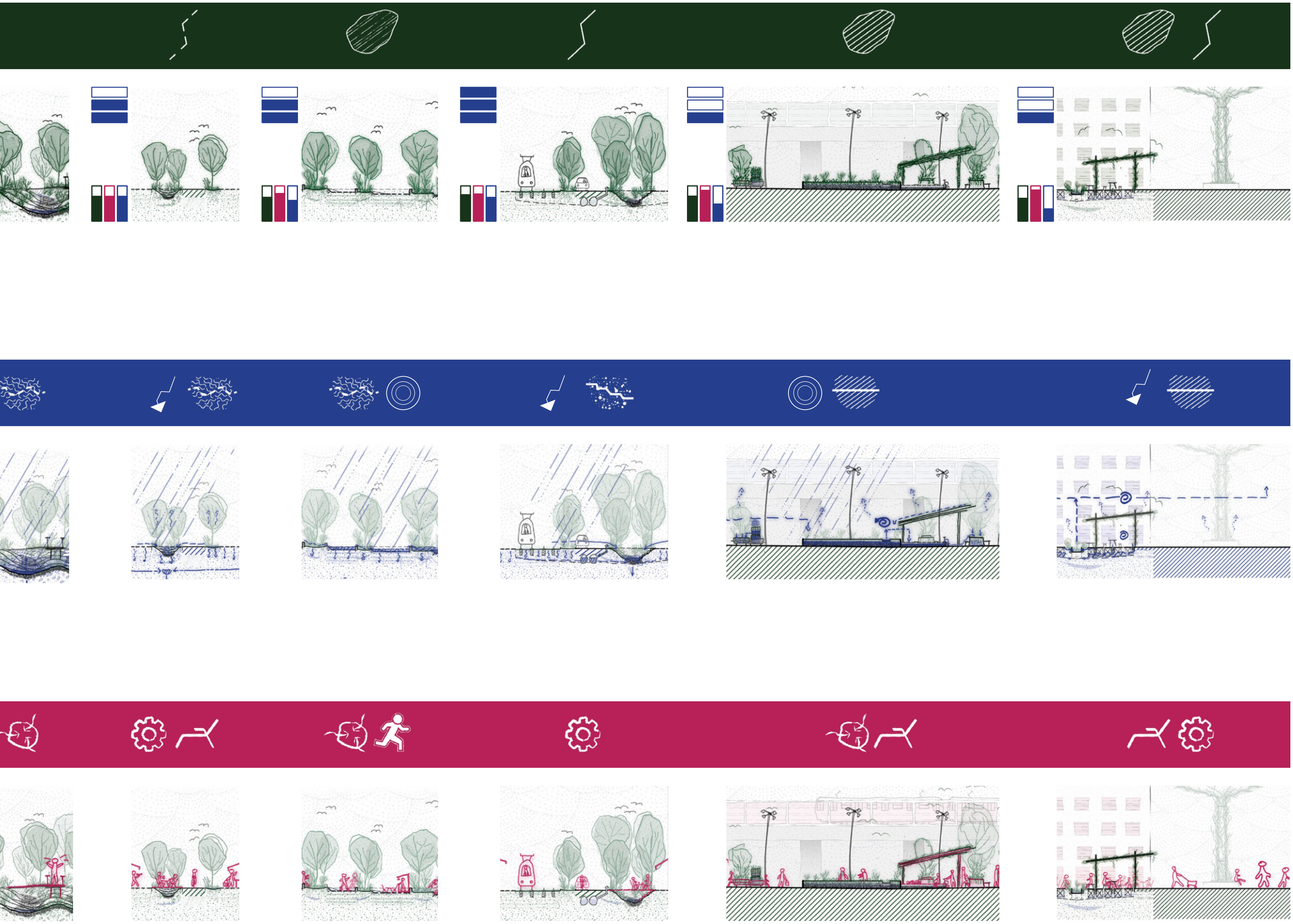
# 5. Climate-resilient assemblage of Vienna
## 5.1 Principles as toolbox for Vienna

Comparing Favoriten to Hernals unveils divergent approaches and design strategies. In Favoriten, distinct design methodologies were employed, necessitated by varying landscape morphologies, thereby expanding the scope of research.

Identifying pertinent urban, landscape, and social characteristics is imperative for tailoring solutions to specific locales and seamlessly integrating them into the system, thereby fostering climate resilience. A structured approach is essential in this endeavor. Evaluating information through the lenses of social, environmental, and hydrological considerations serves as a robust framework. This threefold perspective elucidates the societal impact, environmental contribution, and hydrological relevance of the collected data, facilitating systematic assessment and integration.

Consequently, a catalog of evaluated design principles emerged, delineating potential interventions for fostering a climate-resilient Vienna. These principles encapsulate diverse urban landscape patterns and address varying social needs, providing accessible solutions. However, contextualizing these principles to specific locations and adapting them to pertinent planning and weather scenarios is paramount, ensuring their efficacy and relevance.





# 5.2 Design Principles as elements of a wider system

### PRINCIPLES ASSEMBLAGE

Creating specific design principles for Vienna, incorporating local morphological patterns and social needs, proved more adaptable than a static vision for the entire city. This approach aligns with a transformative and adaptive planning method, allowing versatile responses to uncertainties in resilient urban planning. The collage city concept by Colin Rowe, enables an assemblage of elements and systems, accommodating the socio-ecological structure of local contexts without disrupting the overall urban fabric and redefining its entire structure (Rowe, 1994).

The resultant outcome, depicted in Figure [152], illustrates a climate-resilient scenario wherein designated design elements are integrated within the context of Hernals, fostering a symbiotic relationship between human inhabitants and the ecosystem.

[Fig. 152]: Assemblage of design elements in the context of Hernals as climate-resilient Vienna

### Assembly of principles in diverse weather conditions

In light of unpredictable factors such as evolving planning objectives, shifting governance dynamics, fluctuating weather patterns, and changing societal expectations, it's essential to recognize that the outcomes of envisioned interventions may vary significantly.

Adapting interventions to address location-specific requirements guarantees a tailored approach, catering to the diverse needs of communities.

Figure [153] illustrates the climate-resilient context during a rainy period, depicting flooded waterbodies while exemplifying resilience.

[Fig. 153]: Assemblage of design elements in the context of a rain season in a climate-resilient Vienna

# 6. Conclusion & Reflec

## 6.1 Conclusion

## 6.2 Reflection

# CTION

This chapter is devoted to the reassessment of the research project, involving a re-evaluation of the research questions and their sub-questions within the context of analysis and design. Additionally, it includes a personal reflection on various factors, such as the methodology employed, the project's value, transferability, and limitations of both the project and its results.

# 6.1 Conclusion

*How can a just climate resilient transition in Vienna be fostered by reimagining the green-blue system?*

Fostering a just and climate-resilient transition in Vienna relies on reimagining the green-blue system through a systemic and integrated approach. Recognizing the interconnectedness of multiple systems is crucial, necessitating a layered framework that harmonizes ecosystem and societal benefits, merging climatic advantages with social values.

The key lies in adopting a metropolitan perspective and establishing a green-blue framework supported by a collaborative strategy that encourages bottom-up actions and participation. Prioritizing local knowledge and social demands through an inclusive decision-making process is paramount.

Considering morphological interrelations between urban and landscape elements leverages natural potentials, with renaturation and integration of water landscapes as green corridors connecting existing spaces. Seamless incorporation of public institutions into the green-blue network strengthens resilience and encourages collaboration.

Design principles facilitating customization of interventions to context-specific demands and characteristics of each location within Vienna ensure a bespoke approach, serving diverse community needs. This guarantees that interventions are tailored to address multiple purposes in specific areas, catering to the community's diverse needs.

In summary, a transformative reimagination of the green-blue system is essential for a just and climate-resilient Vienna. This involves a layered, systemic approach, active collaboration, and context-specific interventions into a broader framework, ensuring a sustainable and resilient urban future.

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## RQ1 Conceptual frame

*How are spaces and systems that influence a climate resilient transition identified?*

Spaces and systems influencing a climate-resilient transition are identified through the use of resilience theory, particularly emphasizing ecological resilience and citizens' adaptive/transformative capacity. Healthy ecological systems, crucial for human well-being, especially in urban areas, serve as the foundation. However, the marginalization and displacement of these systems in urban environments contribute to a lack of resilience to climate change, leading to a societal mental disconnection from the biosphere (Gómez-Baggethun and Barton, 2013).

To achieve climate resilience, a transformative shift in behaviour is essential, involving the integration, valuation, and stewardship of ecological systems (Folke et al. 2010, Folke 2016). Green spaces and their stewardship are highlighted as crucial elements in resilient urban social-ecological systems (Colding and Barthel, 2013; Connolly et al., 2014). The adaptive and transformative capacity of society is identified through factors like awareness and knowledge capacity, engagement, and collaboration. A healthy ecosystem as a knowledge system, just distribution of these resources, and solid public and societal institutions are integral to fostering climate resilience (Brown 2012).

In city design, it becomes crucial to consider landscape morphology and integrate the values of resilience and ecosystems into the urban system. The emphasis on green-blue system integration and strengthening societal connections to these systems is imperative for ensuring climate resilience in cities.

*What are methods to ensure an enviromentally just transition of the green-blue system with benefits for all actors?*

Ensuring an environmentally just transition of the green-blue system with benefits for actors involves several essential methods. Grounded in environmental justice theory, the fair distribution of accessible ecosystem benefits, regardless of financial and social means, is paramount (Haase et al. 2023).

Recognizing an unintentionally uneven distribution of ecosystem services, the focus is on initiating an environmentally just transition within the most marginalized segments of society. This entails directing efforts toward urban areas marked by low incomes, high population, and building density. Furthermore, social vulnerability can be addressed through limited per capita living space, migration backgrounds and educational level.

Urban development towards ecosystem/green-blue system integration often leads to gentrification and displacement processes affecting marginalized populations. To proactively mitigate this green space gentrification, the transition centers on areas with a substantial presence of social housing, safeguarded from gentrification due to their public ownership structure.

An inclusive & co-creative process that addresses the needs of all stakeholders, encompassing diverse cultural backgrounds and generations, is indispensable. Actions should make climatic and ecosystem processes comprehensible, provide inclusive interventions for ecosystem services, and address associated challenges and opportunities.

Developing social institutions as central hubs for knowledge dissemination and stimulating them through spatial and organizational integration into the green-blue network is crucial. This approach, strengthening public institutions, enhances the quality of awareness, engagement, demand, and application, ensuring a transition that benefits for human and non-humans.

## RQ2 Analysis

*How can the landscape and urban morphology disciplines help to unfold and design the green-blue system as part of the socio-ecological system towards benefits in heat mitigation and increased climate awareness?*

The landscape and urban morphology disciplines are essential in unfolding and designing the green-blue system within the socio-ecological system, contributing significantly to heat mitigation and heightened climate awareness.

Bringing these disciplines into context unveils intricate relationships and spatial patterns, shedding light on the potential and identity of landscape attributes, notably the complex water system imprint. This revelation is foundational, offering leverage for strategically integrating a green-blue infrastructure.

By pinpointing leverage points, this integration facilitates the inclusion of biodiverse and accessible ecosystems in proximity, nurturing the development of a green-blue network woven into the urban fabric and societal identity. Awareness is fostered through ecosystem stewardship, acting as an entry point to the socio-ecological systems. This comprehensive approach underscores the pivotal role of landscape and urban morphology in unfolding and designing the green-blue system.

*What is and was the role of the green-blue system of Vienna and how do other systems interrelate?*

The green-blue system of Vienna has played and continues to play a vital role in shaping the city, serving as a cornerstone in its daily life and overall functionality. This intricate system is seamlessly spatially and socially intertwined, forming a deep interrelation within the broader urban context.

However, contemporary developments have witnessed a transformation in the role of the green-blue system. Today, it primarily functions as a controlled and engineered functional infrastructure, characterised by displacement and uneven distribution, potentially diminishing its social and ecosystem values. This shift raises concerns about the disconnection of the social fabric and the ecosystem.

Despite extensive displacement, the system's intrinsic connection with both the social fabric and the broader urban ecosystem suggests the potential for reconfiguration. This offers an opportunity for the city to enhance its climate resilience through a renewed relationship with the green-blue system.

*What are constraining factors in Vienna due to engineered resilience and vulnerability, in light of a heat mitigating nature-based infrastructure?*

In Vienna, the interrelation of the current green-blue system with the urban infrastructure presents opportunities and challenges for implementing a nature-based, heat-mitigating infrastructure. The engineered urban infrastructure often aligns with ecological/ environmental landscape attributes for climate mitigation, and constraints arise due to the historical suppression and displacement of the current ecological landscape.

The current ecological landscape, characterized by compaction, soil displacement, and long-term sealing, poses challenges for nature-based solutions and green-blue systems. The soil's interconnected conditions, natural processes, and ecosystem values have been significantly disrupted, necessitating extensive time and construction efforts. The reintegration of a nature-based green-blue network into the urban environment involves substantial planning and engineered interventions, limiting the immediate implementation of these strategies, and opposing immediate nature-based processes. Striking a balance between natural ecosystems and engineered urban systems that ensure functionality is essential.

Spatial constraints further complicate integrating natural green-blue systems, as they typically require more space than engineered solutions. In urban environments, competing demands for limited space create complexity, especially when individuals are reluctant to relinquish conveniences facilitated by an efficiency-driven and car-centred planning approach.

Vulnerabilities in society present additional constraints. Many individuals, particularly in marginalized communities, may lack awareness of climate-related problems, making it challenging to communicate and raise awareness effectively.

Additionally, the societal perception of cars as status symbols, especially in vulnerable segments, poses resistance to changes in mindset and a shift towards sustainable modes of living.

Effective inclusion of all societal segments in co-creative processes, thereby ensuring vulnerable populations have a voice in developing green-blue infrastructure, remains a persistent challenge, hindering social value for this part of the population.

## RQ4 Design

*How can the green-blue system be reimagined in Vienna for a climate resilient system?*

Reimagining the green-blue system entails the development of context-specific interventions that transparently showcase their integration and value contribution across various systems in Vienna. These interventions should cater to diverse socio-ecological patterns, fostering a climate-resilient urban design for the entire city without disrupting the functionality of other systems, such as the mobility system. This reimagining process necessitates reconfiguring the street scapes emphasizing a communal and eco-friendly approach aligned with the city's planning and mobility goals.

Representing these interventions through a layered and systemized approach provides a comprehensive understanding of their values to the social and ecological systems, enhancing the quality of life and climate resiliency. Significantly, these solutions can be developed within a framework that benefits the entirety of Vienna without requiring a complete restructuring.

Resilience is strengthened by integrating social infrastructure and institutions into the green-blue network. This integration facilitates increased ecosystem education, promotes awareness, and enhances societal connectivity to the ecosystem. The reconnection to society is essential to this process, fostering a harmonious relationship between urban environments and their inhabitants

# 6.2 Reflection

## Relation

*1. What is the relation between your graduation project topic, your master track (Urbanism), and your master programme (MSc A UBS)?*

### Topic and studio

The "Metropolitan Ecologies of Places" studio adopts a systemic approach, focusing on circular urban metabolism and crosscale climate adaptation strategies, to identify issues, define leverage points, and propose interventions. This methodological emphasis on systemic thinking seamlessly aligned with the thesis on achieving climate resiliency for Vienna.

Utilizing this approach, I identified urban systems directly connected to climate change challenges, formulating systematic strategies to enhance resilience in Vienna's intricately linked urban and landscape morphology.

This thesis focuses on green-blue systems as leverage points to strengthen Vienna's urban ecosystem and interconnected social systems. The systemic and layered approach, characterised by crosscale analysis and design, enabled me to pinpoint key leverage points, fostering meaningful change within the socio-ecological system.

In the final stages, this approach guided me in formulating systemic interventions dedicated to fostering Vienna's metropolitan ecosystems. The evident alignment between the thesis project and the studio's topic and approach underscores the seamless integration of systemic thinking, complementing the thesis objective of achieving social and environmental sustainability within the metropolitan metabolism.

### Topic and Urbanism

The thesis project "Watercity Vienna" envisions an urban environment in harmony with its characteristic ecosystem. It is achieved through a spatial transformation of public spaces and the seamless integration of a green-blue network. This aligns closely with the goals of the Msc Urbanism Track, which seeks to advance and shape future urban environments in synergy with their natural surroundings, adapting to evolving conditions. It emphasizes a holistic approach that considers socio-ecological contexts, acknowledging their impracticalities and unpredictabilities while addressing spatial injustices..

### Topic and Master Programme

By researching one of the most pressing issues of our time and exploring how we can sustain living in our built environments amidst global warming challenges, resource scarcity and ecological deprivation, this thesis project directly contributes to the Master's Program and the university's goals.

# Methodology (I)

## *2. How did your research influence your design/ recommendations and how did the design/ recommendations influence your research?*

Employing a research-by-design approach, the intertwining processes of analysis and design unfolded in iterative cycles across various scales. This dynamic and cyclical research methodology facilitated the adoption of diverse, mutually influential perspectives – that of both a researcher and a designer.

The researcher's perspective allows one to categorise, contextualise, and understand issues within the framework of theories and systemic thinking.

Conversely, the designer's perspective, rooted in imagination and a human perspective, allows for the spatial and visual abstraction of facts. This approach facilitated the synthesis of different layers using various representation techniques. The designs utilized representation techniques such as maps, sections, axonometries, and visions, enabling the gradual integration of layers and their associated changes, challenges, and opportunities.

This dynamic and layered approach effectively combined disparate contexts, revealing previously invisible interrelations. This comprehensive methodology led to insightful conclusions and empowered the development of a design capable of instigating systemic changes across interconnected systems. The resulting network of interrelated systems, multifunctionally serving different purposes, envisions a design that fosters societal change towards environmental and societal justice. It aims to strengthen ecosystems and create a climate-robust and adaptable urban environment.

## Methodology (II)

*3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?*

### Reflecting on approach and methods

The thesis endeavours to frame a comprehensive approach to understanding the intricate systems and processes vital for achieving urban climate resiliency. The primary thesis focus is on harnessing resilient ecosystems while recognizing the inherent connection between humans and nature. This objective is pursued by displaying the integration of the ecosystem's values as a green-blue system in the urban environment, underscoring its social values to facilitate a societal reconnection with nature.

However, adopting a stewardship role and showcasing the ecosystem's value entails considering non-human perspectives. This involves grasping the meaning of resilient, healthy ecosystems, their specific functioning in the Viennese context, and their original state before extensive human influence. While revealing the initial state is challenging due to centuries-long human impact, recent centuries, marked by industrialization and modernity, especially have witnessed well-documented displacements and control of the green-blue system. Understanding how inhabitants interacted with the landscape through studying the cultural landscape proves invaluable.

Consequently, this research delves into landscape and urban morphology, exploring their mutual influence from the 16th century to the present. Examining the change in the ecosystem within the urban environment allows for contextualization and identification of potentials. This transformation is documented through a comparative analysis of historical and present visuals, including pictures, collages, drawings, maps, and GIS data, illustrating the green-blue and social systems within Vienna's built environment



### Analysis process

The systemic and layered investigation, considering ecosystemic, urban, and social interdependencies, has proven valuable. This approach, based on the premise that everything influences something, unveils effects, revealing the agencies of the subjects present.

Initiating the analysis with the "Green System" helped comprehend the value of urban ecosystems, leading to the identification and characterization of various landscapes and ecosystems in Vienna through maps and collages. The layered approach, incorporating the social system, exposes disparities and dispersion of ecosystems concerning biodiversity, and service provision, highly influenced by spatial and urban patterns. Employing the microstories methodology, which involves collecting/ listening to the subjective needs and opinions of inhabitants, connects social values to these spatial findings.

Investigating hydro-geomorphological dynamics reveals crucial characteristics for ecosystem existence, such as erratic, connected, and cyclic formation processes, providing insights into spatial and functional opportunities for green-blue network integration within urban systems.

The intertwining research into natural dynamics, human interference, biotic response, and social dynamics demonstrates the density of interactions between different systems and their actors. Utilizing representational techniques, such as maps and sections with images and objective opinions, proves beneficial in relating territorial processes to cultural processes and hydro-geological characteristics.

The analysis phase concluded by developing a conclusion map, illustrating the essence of the design concept at the city scale and formulating the main principles for subsequent design work.

The study of Vienna's urban and landscape morphology was instrumental in identifying spatial and morphological patterns, forming the basis for developing principles for integrating a blue-green network applicable throughout Vienna's design exploration.

Mapping emerged as the method of choice to understand and represent these complex systems across time and scale.

### Design process

The design process aimed to spatially integrate a social green-blue network based on developed conclusive principles. It initiated with creating a system, categorizing urban situations for systematic and scalable interventions across Vienna. The research by design method led to a dynamic and prolonged process involving circles of analysis at different scales followed by design iterations. This approach, while tedious, facilitated an accurate and interconnected understanding of the project areas.

Mapping analysis of the research areas, using the conclusive principles, identified a set of main principles, forming the strategy. An explorative design process then examined their integrative spatial feasibility, conducted in sections to consider surface and sub-surface conditions and include a human perspective. Additionally, it enabled the layered representation of multifunctionality and values within different systems. Designing via sectional drawing enhanced spatial understanding and enabled the abstraction of interventions.

A catalogue of design principles for Vienna, derived from the sections, was created and categorized based on urban-landscape patterns, ensuring applicability beyond the focus areas and across different scales.

Reflecting on the process, a stringent commitment to fewer theories and methods could have provided a more precise structure and focus. I recognize that the thesis ambition to address multiple aspects simultaneously complicated and hindered the development of the project. Establishing and adhering to clear boundaries when undertaking a research project is valuable.

This presented challenges and fostered difficulties in looking at systems in singularity and organizing them. Managing the vast amount of data, staying focused on singular issues and structuring information to avoid overwhelming complexity became crucial aspects of the research process.

Finally, I acknowledge that relinquishing certain information, early strategic decision-making and commitment to final investigation areas significantly contribute to the quality of the work.

# Methodology (III)

## Methodolgical considerations

The initial aim of creating a pattern language was discarded during the design process, as the spatial systemization methodology had already achieved a comprehensible intervention allocation. The pattern language could also compromise the level of detail in the design exploration and limit the layered representation of values. The necessary testing of the pattern language in the context of participatory workshops was beyond my capacity.

Creating specific design principles for Vienna, incorporating local morphological patterns and social needs, proved more adaptable than a static vision for the entire city. This approach aligns with a transformative and adaptive planning method, allowing versatile responses to uncertainties in resilient urban planning. The collage city concept by Colin Rowe, enables an assemblage of elements and systems, accommodating the socio-ecological structure of local contexts without disrupting the overall urban fabric and redefining its entire structure (Rowe, 1994).

While refraining from a holistic vision for Vienna, I acknowledge that applying the design principles in a participatory workshop would have enriched the value of the design principles as a co-creative and inclusive tool, increasing comprehension of the design elements.

Overall, this iterative process, blending research, design exploration, and strategic decision-making, contributes to a comprehensive understanding of the urban ecosystem and sets the foundation for fostering Vienna's socially and environmentally sustainable transformation

## Limitations of method

In pursuing a comprehensive understanding and effective communication of this research, certain limitations within the methods employed have come to light. Acknowledging these constraints is crucial for refining future approaches and ensuring the integrity of the research outcomes.

### Microstories: Inclusivity Challenges

While the microstories approach served as a valuable tool for gathering individual narratives, its limitations in inclusivity became apparent. The method's effectiveness is questioned, as accessibility tended to favour individuals who could more readily relate to my appearance and the nature of thesis questions. This unintentional bias raised concerns about the broader representation of diverse perspectives. Language and social barriers further compounded these challenges, making it difficult to include the opinions of individuals from more vulnerable groups, particularly those with a migration background.

### Limitations of Representation Technique - Sections

While using sections as a representation technique has provided valuable insights, it is not without its constraints. This approach, although insightful, offers only a limited portrayal of interventions, making it challenging to capture their entire character and comprehend their holistic impact. The difficulty lies in presenting a comprehensive view of interventions' overall connectivity and network systems, hindering a nuanced understanding.

To overcome this limitation, axonometries were introduced in the later stages of the research. This addition aimed to provide a more inclusive and comprehensive view of the entirety and connections of interventions, offering a more holistic perspective on their spatial integration.

These methodological limitations underscore the importance of continuous refinement and adaptation in the research process. They serve as valuable insights into the intricacies of engaging with diverse perspectives and visualizing complex interventions.

## Relevance

*4. How do you evaluate the academic and societal scope and significance of your project?*

### Academic value

By exemplifying the application of systems thinking and academic research in Vienna in an understandable manner, this project effectively bridges the gap between academia and practical application.

Given the escalating complexity of urban systems and a growing fragmentation of expertise, as highlighted by Giseke et al. (2021), along with the corresponding disciplinary divisions within academia, the objective was to present theories and related interventions in a comprehensible format. This initiative aims to enhance accessibility for groups outside the academic sphere.

### Societal value

By incorporating societal value into all climate-resilient interventions and adhering to spatial justice principles, a greater societal good is consistently prioritized

## Transferability

*5. How do you evaluate the transferability of your project results?*

### Transferability of Interventions

Generic urban interventions face limitations in transferability due to various unpredictabilities and diverse characteristics, including morphological, geological, cultural, social, and functional aspects. Site-specific assessments through measurements, analyses, surveys, and participatory processes become imperative to validate interventions. However, the primary goal of the thesis project is to illustrate ways of integrating a blue-green infrastructure, making it understandable to a broad audience. This involved visualizing spatial potentials and flexible solutions, breaking from conventional images like sealed and car-dominated urban landscapes. These representations aimed to reveal forgotten and potential future qualities, showcasing how people can thrive within marginalized urban environments, benefiting from ecosystem services.

Considering this, the project's results are highly transferable due to considerations of diverse Viennese urban and landscape morphologies and social requirements. Organizing interventions based on these abstracted characteristics enhances their easy transferability to local contexts.

For transferability to other urban environments, similarity in hydro-morphological characteristics is crucial. If the urban landscape shares features like Vienna, characterized by topography and a water landscape, direct transferability of design principles becomes viable.

### Transferability of methodology

The applied methodology centred around multi-scalar and multi-temporal considerations of urban and landscape morphology and social patterns can be extrapolated to other urban landscapes. The design investigation, facilitating the integration of blue-green and social infrastructure, paves the way for developing a catalogue of design principles for (urban) environments with other morphological characteristics.

## Limitations

### *6. What intentional exclusions did you make in your study?*

Resilience research and planning for transformation and adaptability typically involve considering various scenarios to respond to uncertainties and unpredictable future pathways. Using a scenario construction approach might have clarified the selection of resilient planning pathways but could compromise the level of detail in the design exploration. Given that this thesis primarily takes on the form of a design project, the feasibility of implementing this approach was limited. Consequently, the project did not delve into preparing different scenarios. Instead, it operated under stagnation or deterioration in climatic and weather conditions, coupled with reduced public space use by motorized individual vehicles (MIV). Grounded in resilience theories based on ecological resilience, the chosen design scenario challenges the continuation of engineered resilience or hard infrastructure measures, advocating for a transformation toward ecosystem-based resilience in urban spaces in Vienna.

With its interconnected soil conditions, natural processes, and ecosystem values, the current Viennese landscape has been significantly repressed and displaced, requiring centuries for its functions to recover fully. Compaction of the soil, accumulation of sand and gravel, and long-term sealing have replaced soil functionality. Often, their natural ecosystem capacity is profoundly affected. The restoration process demands many years and considerable construction efforts to integrate nature-based solutions or green-blue networks and their ecosystem functions into the urban environment. This reconfiguration and reintegration into the urban environment involve substantial (engineered) interventions, limiting the immediate implementation of natural processes and nature-based solutions. However, a gradual application is recommended given the centuries-long suppression of the ecosystem and the urgency posed by climate warming and associated issues for the built environment.

In this work, the primary focus is on fostering ecological and natural water cycle systems in public urban environments. However, human impact on these systems in the cultural landscape, upstream areas, or private spaces also significantly contributes to climate resiliency. A holistic approach to the entire green-blue system is crucial for long-term impact. Due to the constraints of the master thesis framework, the scope of the work is limited to urban public spaces. The accessibility of these areas by municipal entities, with fewer limitations from private owners due to municipal ownership, simplifies the feasibility of implementation.

It is essential to highlight that the sections presented in the research represent an idealized and abstracted best-case scenario for a socially and environmentally compatible transformation of public space. However, their feasibility in specific situations may vary, requiring technical and functional validation by relevant experts. This limitation affects the project's impact and accountability. Integrating different research fields could significantly enhance the understanding and response to the situation at hand, adding valuable perspectives to the project.

## Field trip

*7. How did the field trip influence your project and alter your perception?*

Integrating a field trip and engaging with stakeholders, like residents, fellow students, friends, and researchers in Vienna, played a pivotal role in sharpening the focus and addressing problems within feasible boundaries. Seeing focus areas firsthand provided a better understanding of the location and evaluated possibilities for future interventions. Trusting personal judgment and initial thoughts within this process proved instrumental in working purposefully towards a result.

## Recommendations

*8. What are some future pathways that you envision for the project?*

A future step involves applying design principles in a participatory workshop to test their benefits among stakeholders. This co-creative approach fosters translating the integration of a green-blue network with added social value into understandable design principles/elements. The result is a co-creative tool, inclusive to non-specialist actors. This iterative process contributes to a comprehensive understanding of the values of urban ecosystems and sets the foundation for a climate-resilient transformation of Vienna.

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