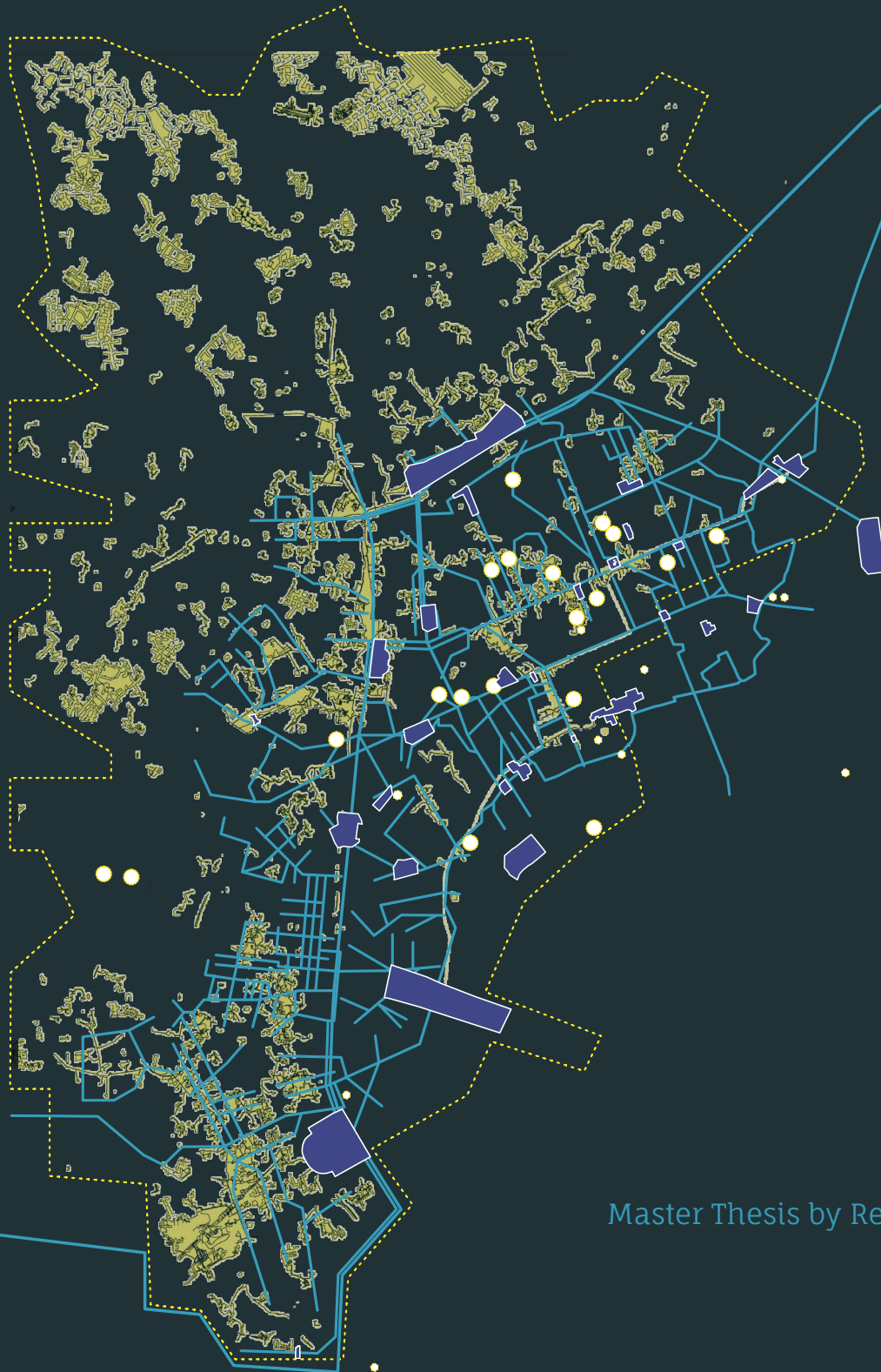


Vertical Blue

Designing the Subterranean Water System of Naples
as a Landscape Infrastructure for Socio-Ecological
and Climate-Adaptive Public Spaces



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Master Thesis Report

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ABSTRACT

The historic center of Naples, recognized and protected as a UNESCO World Heritage site, faces pressing climatical and social challenges, including urban heat islands, desertification processes, tourism challenges and a lack of public space. Beneath its vibrant streets lies a network of underground tuff stone excavations that evolved from building the city above with its underground material. Its forgotten subterranean water landscape of aquifers, aqueducts, cisterns and channels serves as a continuous structure within the layeredness of the subterranean world and bares untapped potential for urban resilience and landscape-based urban development. This system was dug out by hand and therefore consists of human-scale underground spaces. This setting provides conditions that lead to the potential of redefining the understanding of public space in Naples: It is about connecting the surface with the underground public spaces through the water system.

As the water still flows beneath the city, this thesis explores how these underground water structures can reactivate the system it runs through as well as the city's surface public spaces, as a landscape infrastructure that creates better conditions alongside its reach. By connecting subterranean public spaces, aqueducts and cisterns through landscape-based design interventions to surface-level public spaces, the project envisions a socio-ecologically inclusive and climate-adaptive public space network that mitigates the city's vulnerabilities while fostering creating identity and a common sense of belonging to the former water city Naples.

The research maps the existing subterranean infrastructure and its spatial and functional relationships to the public spaces above it. Case studies, fieldwork and photogrammetry data inform strategies for transforming Naples from a two-dimensional into a three-dimensional heritage and climate-adaptive city. The project includes design explorations at multiple scales, combining architectural, ecological, and cultural elements to create surface- and subsurface-level public spaces that cool the city and people, enhance social interaction, a sense of belonging, and celebrate Naples' water heritage again. This work contributes to the discourse on how heritage cities can adapt to future challenges by utilizing landscape-based urbanism approaches that prioritize the vertical logic of the landscape, resilience, inclusivity, and sustainability.

UN Sustainable Development Goals

In 2015, UN member states agreed to 17 global Sustainable Development Goals (SDGs) to end poverty, protect the planet and ensure prosperity for all. This person's work contributes towards the following SDG(s):



Keywords:

Landscape Infrastructure, Naples, Subterranean Landscape, Water-sensitive Design, Public Space, Urban Heat Island, Vertical Blue

CHAPTER I

INTRODUCTION



1

Fascination and Context

This thesis explores the hidden potential of Naples' subterranean world as a catalyst for urban resilience. Beneath the compact and historic center, a network of aqueducts, tuff stone excavations, cisterns and wells silently extends, carrying stories of water, connection and change. Today, as Naples faces profound challenges, these forgotten infrastructures offer new public space opportunities to rethink the relationship between the city's surface and its deeper layers through vertical interventions.

The idea of Vertical Blue as a guiding structure for a landscape infrastructure, is not limited to the case of Naples. Many cities around the Mediterranean and beyond face similar conditions: compact historic centers, heritage restrictions, a lack of surface space, and increasing climatic pressure. Beneath these cities lie overlooked systems that were once closely tied to the geomorphology and daily use of their context. This thesis proposes to view Naples' underground structures not as static remnants but as spatial frameworks that can shape contemporary public space. In cities where transformation on the surface is difficult, vertical connections to landscape features like water and its related structures may offer a design approach that responds to environmental and cultural challenges.



200 000 km

Fig. 1 Location of Naples within the county of Campagnia, Italy

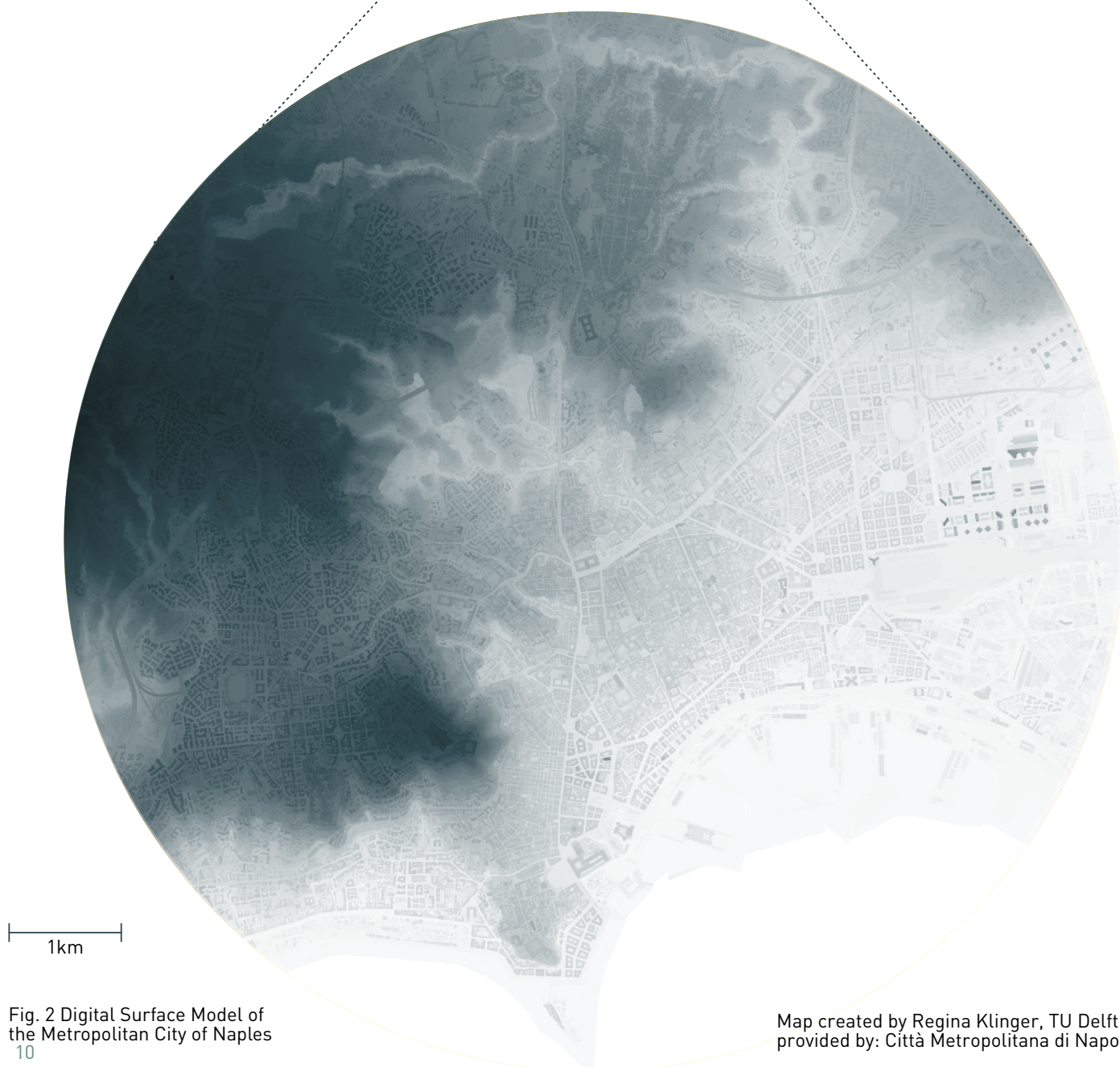


Fig. 2 Digital Surface Model of the Metropolitan City of Naples

Map created by Regina Klinger, TU Delft using data provided by: Città Metropolitana di Napoli (2025)

1.1 Personal Fascination

Through my previous studies, I have come to see that both the abundance and absence of water will play a defining role in the urban contexts of the future. We talk about green cities, but they only will become reality when thinking about the blue. While we face increasing risks of water scarcity, we must also learn how to store and reuse excess water during heavy rainfall events. This is particularly urgent in densely urbanized environments with sealed surfaces and challenging microclimates, where both climatic and social vulnerabilities are intensified and relating to each other. An example thereof is the historic city of Naples, Italy, where the focus on architectural preservation has often overshadowed the landscape's potential as a climatic and social mediator.

In cities like Naples, that are compact, Mediterranean and heritage-protected, the possibility for green infrastructure is severely limited, yet beneath the surface lies a forgotten landscape of water. The city's ancient Greco-Roman aqueducts, cisterns, and subterranean cavities, once monumental systems designed to meet water needs in arid climates, have largely disappeared from the urban mindset and visual urban context of the city. Today, underground Naples exists as a separate, hidden layer, detached from the functioning surface world, despite holding spatial, climatic, ecological and socio-cultural potential. The underground system holds cool air, cold water and a walkable subterranean system, so why not think about it as a second layer of public spaces?

Unlike traditional green infrastructure, which often requires horizontal surface area and ongoing maintenance, water can perform as a punctually applied and space-efficient landscape feature. It can flow vertically, infiltrate underground, be stored, and still generate ecological and experiential impact above ground. I observed that behavioral patterns in water-oriented spaces differ from those in green spaces: People tend to gather more closely around water, linger, and engage with its sensory qualities in more open and spontaneous ways. This fluidity, on both physical and social terms, opens potential for water to function as connective tissue in places where spatial limits prevent resilient, valuable and uniting public space from taking form.

Simultaneously, Naples suffers from the combined pressures of climate change, desertification, mass tourism, a lack of public space and uncontrolled, radical urban development. These dynamics not only degrade the built environment but also erode opportunities for everyday public life. Many Neapolitans live in precarious conditions in *vasci*, one-room ground floor units that often have only one single opening directly into the street. This makes the quality of public space just outside the door critical to urban well-being and health. Yet, in many areas of the historic center, this kind of resilient and connective public space is missing, and a sense of neighborhood, identity and belonging is not being able to hold the city together.

"Vertical Blue" seeks to answer the question on how water can become a guiding agent in restoring and creating new public spaces in the underground and on surface level, enhancing new micro-climates and strengthening social cohesion within a spatially constrained and heritage-protected urban landscape. By moving vertically between surface and subterranean, the project invites to rediscover Naples as a complex, breathing landscape where depth, movement and memory come together.

1.2 The location of Naples

"We are a city in the global North, but in the South. And we are much more similar [...] to the South than to the North. So, we have all the tools of the North, all the laws, equipment, bureaucracies [...] of the North. But then we are south, we are south of the North, so everything is complicated, very complicated."

-Professor Federica Palestino (2024)



Fig. 3 Informal use of the public space and buildings within the heritage site of Naples



Fig. 4 Informal use of the public space and buildings within the heritage site of Naples

As stated by Professor Palestino, Naples can be described as a difficult and unpredictable context. It has a long transformational history, including several invasions, volcano eruptions, wars, urban renewals and economic crisis. While urban development processes are being part of the discussion and practice, a public program promoting recovery and restoration of the city was not put into action (Esposito, 2023).

1.3 Problem Statement

The historic center of Naples is unable to meet the socio-ecological and climatic needs of its population. Public spaces are fragmented, commercially oversaturated, and inaccessible to those most vulnerable, particularly residents living in precarious ground-floor housing. At the same time, the city's dense and heritage-protected structure limits opportunities for green infrastructure or conventional spatial interventions.

Beneath this surface lies a largely disconnected system of subterranean water infrastructure, a forgotten but spatially rich layer of cavities, aqueducts, channels and cisterns carved out of porous tuff stone. This underused system holds untapped potential to be reimagined as landscape infrastructure for inclusive, climate-adaptive public space.

This thesis investigates how Naples' subterranean water system can be reactivated to support a new type of public realm that is both a provider of public space itself but at the same time a catalyst for surface-level public spaces; one that addresses spatial scarcity, climate resilience, and social cohesion in a compact historic city.

1.4 Hypothesis

This thesis departs from the hypothesis that water, especially subterranean water and its accompanying human-made transportation systems, can become a guiding agent in spatially constrained, climatically challenged urban heritage landscapes (UHL), as they are mostly adapted to the landscapes features, like aqueducts following the elevation and water abundance of the landscape. This thesis builds on the theory of landscape infrastructure, which frames landscape as a systemic, multifunctional, and resilient foundation for urban transformation, forming a zone of better conditions along its infrastructure (Nijhuis & Jauslin, 2015). The research explores how Naples' subterranean water systems can be reactivated as a systematic backbone for landscape infrastructure, reconnecting surface and subterranean worlds to generate climate-adaptive, socio-ecologically valuable, and heritage-sensitive public spaces in the heart of the city. By understanding and redesigning the water system not only as a functional infrastructure, but as a multi-dimensional public space, it can support new forms of public life above and below ground. Through small scale interventions and the strategic use of vertical blue connections, including cool water, air and humidity, the water heritage can be made visible, audible and accessible again. The water infrastructure holds the potential to structure the city's public space system more adaptively, provide local climate relief and support social inclusion in areas ruled by neglect and increasing tourism pressure.

The hypothesis assumes that this layered, vertical landscape infrastructure can spatially and atmospherically improve both public space and everyday life in heritage-protected environments.

Naples today

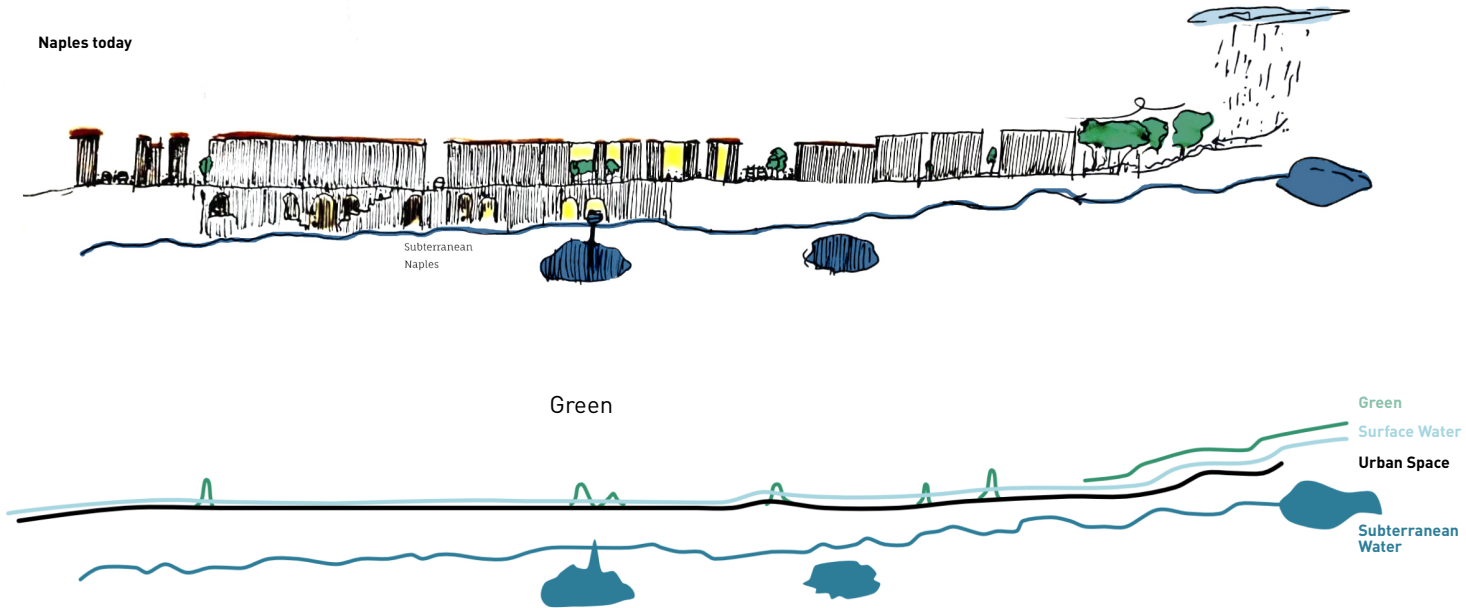


Fig. 5 Quick sketch session of Naples today - to create a guiding vision throughout the research process of how Naples can transform via the use of the landscape of the water system

Naples tomorrow

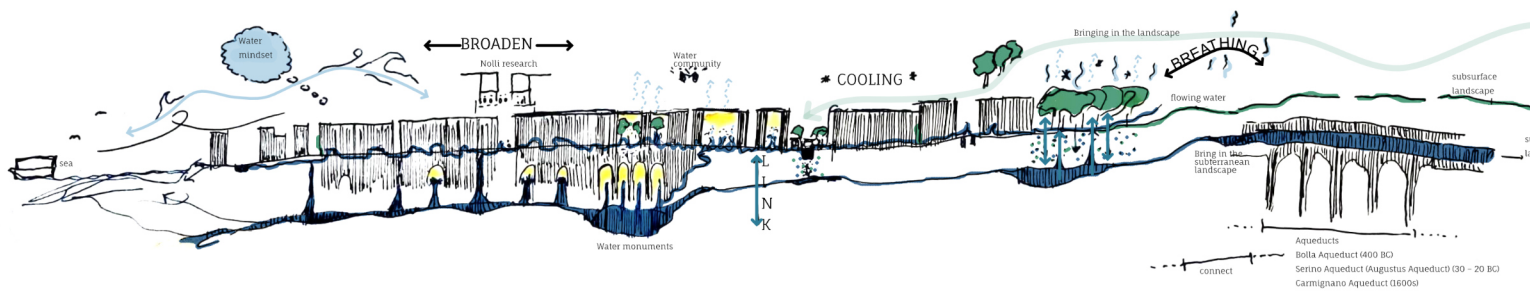
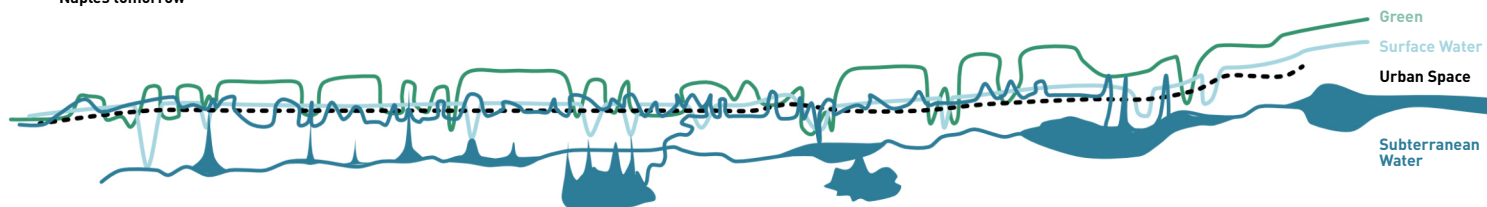


Fig. 6 Quick sketch session of Naples in the future - to create a guiding vision throughout the research process of how Naples can transform via the use of the landscape of the water system

1.5 Research Objective

The idea of reimagining subterranean water systems as a landscape infrastructure forms the basis of this research. This infrastructure is used not only to respond to climate challenges and spatial scarcity, but to reconfigure public space as a just, inclusive, ecological, and socially embedded system. It addresses therefore the main research objective:

How can we utilize the subterranean water system of Naples as a landscape infrastructure for socio-ecologically inclusive and climate adaptive public space structures?

To address this research objective, a couple of sub-questions need to be answered. The research first investigates the functioning and structure of Naples' subterranean water system and its connection to the surface realm:

How does the subterranean water-system of Naples work and how is it connected to the city's public space structure?

It then explores design principles and strategies that can be applied to re-activate water public domain through the subterranean world:

What are the existing strategies and principles to use subterranean water systems to activate public space?

Further on, it translates these insights into a multi-dimensional design proposal for Naples:

How can we apply the findings to design a multi-dimensional landscape infrastructure for the city center of Naples?

And finally, reflecting back, the research showcases the lessons learned on how buried infrastructures can support future-proof public spaces in complex, dense urban heritage contexts:

What lessons can be learned by regarding subterranean water systems as leverage for developing future-proof public spaces?

1.6 Summary of Methods

To address the research questions, this thesis applies a layered methodology combining spatial, historical, social and experiential research. Mappings are used to identify the structure and accessibility of the subterranean water system on both systemic and architectural scales. Social analysis focuses on ground-floor living conditions, use of public space and the relationship between people and water. Ecological research focuses on blue and green infrastructures and their accessibility within the city of Naples but also the qualities of the tuff soil. Site visits, photogrammetry and expert interviews complement the desk study with observations, subterranean data and local narratives. Case studies from cities such as Kaymakli, Derinkuyu, Istanbul, Tetouan and Venice provide comparative insights on subterranean water structures as a public space catalyst. Design strategies are developed through precedent research from Athens, Antwerp, Utrecht and Pompeii as well as archaeology-sensitive design principles. The method is supported by GIS-based tools and layering-techniques to identify key intervention zones and informs the focus points of the multi-dimensional design. The thesis concludes with a critical reflection on the project's outcome, transferability and a glimpse into future research.

1.7 Relevance

This master's thesis contributes to finding a landscape-based approach to transform Naples' Mediterranean, urban, historic, protected and conservative site into a future-proof city center through landscape-given and neglected subterranean elements.

It contributes to the Master Track of Landscape Architecture, as this work shows how powerful landscape can be when seen as equal as architecture – in this sense as a landscape-driven and organizing infrastructure. An unconventional landscape – detached from the stereotypical green – gets a voice in the protected Italian environment of historic Architecture, which however lacks a landscape-based approach in order to maintain the city as such but also to make it future-proof and perceptive to flora, fauna and human needs in order to assure livability in the future.

In the larger context, understanding and being aware of the subterranean landscapes of our environment is an important step to unveil remnants of the past that might have been forgotten as a valuable source to work with, whether embedded in a rural or urban context. Especially when it comes to heavily urbanized areas, which are in the case of Naples even protected as a UNESCO world heritage, then it is even more important to think further, through levels, scales and surfaces. It is about daring to think vertical in order to have horizontal positive changes on both surface- and subsurface level public space structures.

When it comes to make our environments future-proof in the face of climate change, social differences and extinction of flora and fauna, it becomes crucial to look into the history, learn how to work with what is left and how to activate these systems in a way to connect it to the people, the dynamics of public spaces and highly urban context again. The inhabitants and visitors of Naples not only experience these systems again by having them re-integrated into their everyday lives through context sensitive design, but they also profit from them as they give multi-layered value and quality back to the city. They are getting the chance of re-connecting to the water mindset of their ancestors and city and therefore become the value-keepers for these systems again.

Furthermore, looking into the old historic center of Naples together with its subterranean world provides research potential as it adds a layer of what we understand as landscape (in that case the subterranean landscape) and how we can define, organize and design landscape as a landscape infrastructure, which is a new way of thinking about landscape as a connecting element between levels, elements, disciplines and architecture(s).

With the connection to the subterranean spaces, the inhabitants and guests of Naples may start to see these chaotic and poorly maintained spaces again as their living environment and may start to solve the existing problems there. The subterranean public space is turning into a space of interaction and compassion that is no longer detached from the surface. Through the design, a sense of common belonging is being created – no matter if walking on surface or subterranean level – and therefore this design can contribute to the debate about how we want to live in the future and how we want to live in a relationship to the subterranean history of our cities in times of climate change while introducing more ecological value and future-proof resilience to these places.

1.8 Reading Itinerary

This thesis started from the theoretical foundations to contextual analysis and finally into design strategies and proposals. Chapter I illustrated the fascination with Naples and the core social, ecological, climatical and spatial challenges within the historic city center. It introduced the location of Naples and formulated the problem statement, the hypothesis, and the research objective, while outlining the methods and relevance behind the research.

Chapter II addresses the theoretical foundation which is considering the public spaces and cave structures as landscape infrastructure. It formulates the theoretical foundation through

landscape-based urbanism, landscape infrastructure and blue exposure. In addition, it redefines the understanding of public space in relation to subterranean–surface connections. This chapter also explains the methodological steps, guiding the translation of theoretical concepts into spatial analysis, strategy and design.

Chapter III is deepening out the analysis and arrives at the challenges and opportunities. It explores Naples through multiple scales. It starts with the regional perspective, tracing the history of the water landscape and its development in East, Central and West Naples. It then shifts to the human scale, examining structures such as aqueducts, tuff stone excavations, wells, fountains and green spaces. These analyses evaluate how surface and subterranean systems have evolved and identify typologies of public space within the city center's levels. In addition, a synthesis of narratives surrounding water and underground spaces is presented. International case studies further complement the analysis by investigating heritage cities that integrate subterranean water into urban public life. The cases of Derinkuyu, Istanbul, Tetouan, Venice, Athens, Antwerp, Utrecht and Pompeii provide comparative insights and inform the development of design strategies for Naples.

Chapter IV forms the core of the design proposal. It introduces the overall design strategy and an archaeology-sensitive design approach and applies it across five operational layers: the tuff stone excavations, the aqueduct system, the architectural layer with the metro stations, wells and fountains and the green infrastructure. Each layer is addressed with spatial strategies that aim to connect the subterranean and surface levels through climate-responsive and socio-ecologically inclusive design. The interventions are demonstrated at multiple scales, including the city-wide strategy, the application of it on the city center of Naples and zoom-in applications in the San Lorenzo district around Porta Capuana.

The final chapter V reflects critically on the outcomes, learnings, limitations and future possibilities of the findings. It addresses each research question and discusses the broader implications for the field of landscape architecture. The conclusion outlines the potential of reactivating subterranean water infrastructures as a tool for shaping landscape-based, resilient and culturally grounded public spaces in dense and heritage-protected cities like Naples. This chapter ends with a personal reflection looking back on the process of the whole year.

CHAPTER II

RESEARCH APPROACH



2 Applied Theory and Methods

In spatially limited and climatically vulnerable cities like Naples, water can offer a powerful and space-efficient answer to current urban challenges. While green structures often require horizontal expansion and ongoing maintenance, water flows vertically, infiltrates below, and can be stored or reintroduced to create layered, multifunctional space within highly constrained urban contexts. Naples' subterranean reservoirs and aqueducts, carved into the porous tuff stone, once supported the city's daily water needs and enabled dense construction by hollowing out usable voids underground (Gentilcore, 2019). These structures formed a hidden but vital part of the urban metabolism, where "there is no house, however small, which is not provided with convenient water by the [underground] reservoirs" (Celano, 1692, as cited in Gentilcore, 2019, p. 9). Today, however, this once-integrated water system lies disconnected from public space, despite its potential to serve as both an ecological and social asset.

In relation to this approach, a combination of several theories supports and guides the way through analysis, concept and design processes. Through using and reshaping these theories to adapt them to the situation of Naples, a theoretical basis for this master's thesis is being set up. The framework consists of three main components:



Fig. 7 Line: Single-purpose infrastructure

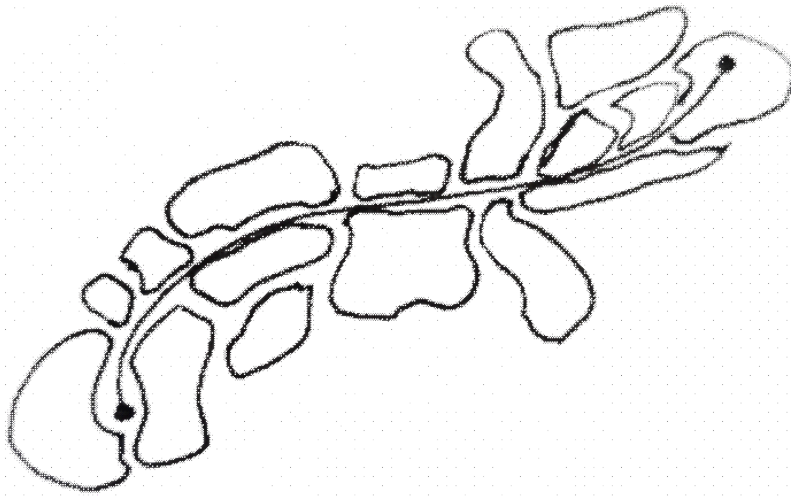


Fig. 8 Zone: Multi-purpose landscape infrastructure



Fig. 9 Vertical and horizontal zone: Three-dimensional Landscape infrastructure

2.1 Landscape-based Urbanism

Landscape-based urbanism serves as the first theoretical pillar of this thesis, emphasizing the landscape as the foundational structure for sustainable urban development. As articulated by Nijhuis (2024, 2015) this approach integrates ecological systems, people and cultural meaning, history and the spatiality of the architectural form into a single operational framework where urban transformation is guided by the logic and dynamics of landscape. It challenges traditional top-down planning by embracing bottom-up processes rooted in place, time, and layered territorial conditions.

In the context of Naples, this theory supports an understanding of the city not as a fixed architectural composition but as a living, adaptive landscape. The subterranean water systems and socio-ecological spatial conditions become players within public space design. By applying this lens, the thesis explores how landscape and particularly water with all its byproducts – like humidity, the water system cavities and cool air – can structure a multi-dimensional public realm that bridges surface and sub-surface urbanism.

2.2 Landscape Infrastructure

Landscape infrastructure offers a conceptual framework that redefines infrastructure not as a separate technical and single-purpose layer, but as an integral part of the urban landscape that serves ecological, social, and functional purposes simultaneously (Nijhuis & Jauslin, 2015). This perspective emphasizes multi-functionality, spatial and systemic connectivity, and resilience across different urban scales. Rather than treating infrastructure as a neutral or invisible background system, landscape-based approaches position it as a designable, adaptive structure that actively shapes and integrates the “space of places” and “space of flows” (Nijhuis & Jauslin, 2015).

In the case of Naples, a space of places addresses specific locations with unique characteristics and whose configuration was shaped by the socio-ecological and economical dynamics. For example, water elements and its ornaments telling the history of the public space, but also the radical absence of urban green is an outcome of past decisions, resulting in the current form of the space. The space of flows however includes the spaces providing water, creating a backbone for navigation below and above surface through the city, offering socially relevant functions for wellbeing and livability and spaces that regulate the climatic conditions and water within the city. In dense and heritage-sensitive environments, this understanding allows for a rethinking of how subterranean water systems can be re-integrated as socio-ecologically embedded, climate-responsive spatial systems that go beyond their singular function, including not only water itself, but also humidity, cool air, air circulation and shelter.

In this thesis, the idea of landscape infrastructure is developed by extending the two-dimensional notion of a linear, multi-purpose system of conditions into a three-dimensional landscape infrastructure where surface and subterranean elements are combined into a layered, vertical sequence of public space and water infrastructure that creates a future-proof network of public spaces structures.

2.3 Blue Exposure

Within this framework, exposure to water-fed elements is understood not only as an ecological or technical element, but as a spatial and experiential one that is shaping how people perceive, navigate, and inhabit urban environments. Visibility, accessibility, and proximity to water influence human health, social behavior, and emotional connection to place. These spatial qualities are especially relevant in dense urban contexts like Naples, where public green is scarce and everyday exposure to natural elements is limited. By restoring the visibility and spatial presence of water that exists both on the surface and through subtle references to the subterranean world, public space can gain a renewed socio-ecological value. Blue space can serve as a connective tissue across fragmented urban landscape, encouraging moments of gathering, reflection, and thermal comfort.

This thesis adopts this understanding by repositioning water and all its side products as a central, perceptible component of urban life. By doing so, it reclaims its spatial, cultural, and social significance in the historic core of Naples. (Zhang, Nijhuis, & Newton, 2023) In this thesis, the understanding water as “Blue” will be extended to not only water bodies but also cooling factors like cool air, mist and humidity.

The previous theories inform the research approach on multiple levels. Taking landscape as the starting point of the thesis helped identify landscape-related structures within the highly sealed and compact context of Naples. The understanding of landscape had to go beyond a surface-based or green interpretation, as the dense historic setting did not allow for extensive horizontal green interventions. At the same time, the heritage character of the site was seen as a value to be respected rather than overwritten.

By reading the landscape as infrastructure and vice versa, the aqueduct was recognized as a continuous element within the layered condition of Naples. Here, the infrastructure of water channels intersects with a geological landscape feature: water sourced from the plains around Mount Vesuvius. This created the possibility to define a spatial line that could shape better climatic, ecological and social conditions. Since the aqueduct connects vertically to the surface through wells and cisterns, it allowed to dare to connect it to the public spaces. The formulation of a spatial zone based on the water system where conditions could be improved without relying on extensive ground-level interventions set the base for the design of a landscape infrastructure.

Based on the early hypothesis that water, when made accessible and perceptible, can generate more value in narrow areas than surface-based greenery, the idea of enhancing conditions through blue exposure and subtle activation of the aqueduct system became central to the research and design process. The blue exposure theory will be developed further by defining blue not only as a representation of water, but also cool air, mist and humidity.



2.4 Redefining the Understanding of Public Space

The combination and reinterpretation of these theories inform the redefinition of public space by activating the vertical potential of Naples' blue infrastructure which is based on the connection of the surface with its forgotten subterranean water systems. Moving beyond conventional, surface oriented urban space, the thesis will point out how the city's layered network can function as a backbone for creating a landscape infrastructure, offering spatial, ecological, and social value in a dense and heritage-protected context. On the one hand, some parts of the water system can be reactivated and on the other hand, these systems can also provide subterranean public spaces for climate shelter. Rather than introducing large-scale transformations, this work focuses on micro-interventions that respect the UNESCO-listed urban heritage landscape while revealing and reprogramming spaces above and below ground. These include punctual interventions like physical access points to the underground, reactivate wells that transport cool water or air to the surface, or create subterranean public spaces by designing, widening and accessing underground excavations and aqueducts. These interventions aim to foster a stronger physical and mental relationship between above and below, allowing the water system to become both a connector and a presence in public life but also the voids that used to inherit water, to give additional space to the city.

2.5 From a two-dimensional to a three-dimensional heritage

The three-dimensionality of public spaces within the landscape infrastructure is not only creating a new public space approach through vertical understanding, but also by taking the lens through landscape architecture allows to think in layers of several dynamic, changing landscapes that all contribute to a certain design outcome. By expanding the traditional two-dimensional view of cities – where only architecture and surface public spaces are considered valuable and protected – towards a three-dimensional understanding, the perception of Naples' heritage shifts as well. In this approach, not only the built environment above ground is recognized and advertised, but also the water systems, underground cavities, and the potential of subterranean public spaces accessible for all. The vertical connections between surface and underground become part of the city's cultural and spatial value, creating a truly three-dimensional heritage. There is the possibility of diving into the subterranean landscapes, using its water-derived features to form a landscape infrastructure that connects on many levels. (Nijhuis & Jauslin, 2015)

While working with the flow of water, of people, the green structure or time, we connect the spatial structures within the public space system that contribute to the experiences and embracement of the processes happening in them. We work with and enhance systems which the Landscape consists of – whether hardscape or softscape. (Corner, 2006)

It is about the assessment of the vertical findings, like excavations, cisterns, aqueducts and aquifers within the landscape-architectural design practice, and see their positive, horizontal impact on the built environment that we find on the surface. It is about turning a two-dimensional UNESCO heritage into a three-dimensional heritage and research on what parts of the city are actually possible to change and adapt to future challenges. It is the provocative search for a middle ground between heritage preservation and climate adaptation that leads to live-ability and resilience in the city of Naples, as the city of Naples has historically struggled to implement coherent urban development and planning strategies. A consistent pattern of poorly executed or entirely absent urban interventions can be observed in both the surface and subterranean planning frameworks. While a public program for the recovery and restoration of the city's immense architectural and infrastructural heritage has long been discussed, it was never effectively put into action (Esposito, 2023). Furthermore, official spatial planning efforts have largely neglected the underground city, treating it more as an archaeological resource rather than integrating it into urban development strategies. For instance, although Naples is required to adopt a General Urban Plan for Underground Utilities (P.U.G.G.S.), the municipality has never fulfilled this obligation. Instead, the subterranean spaces remain

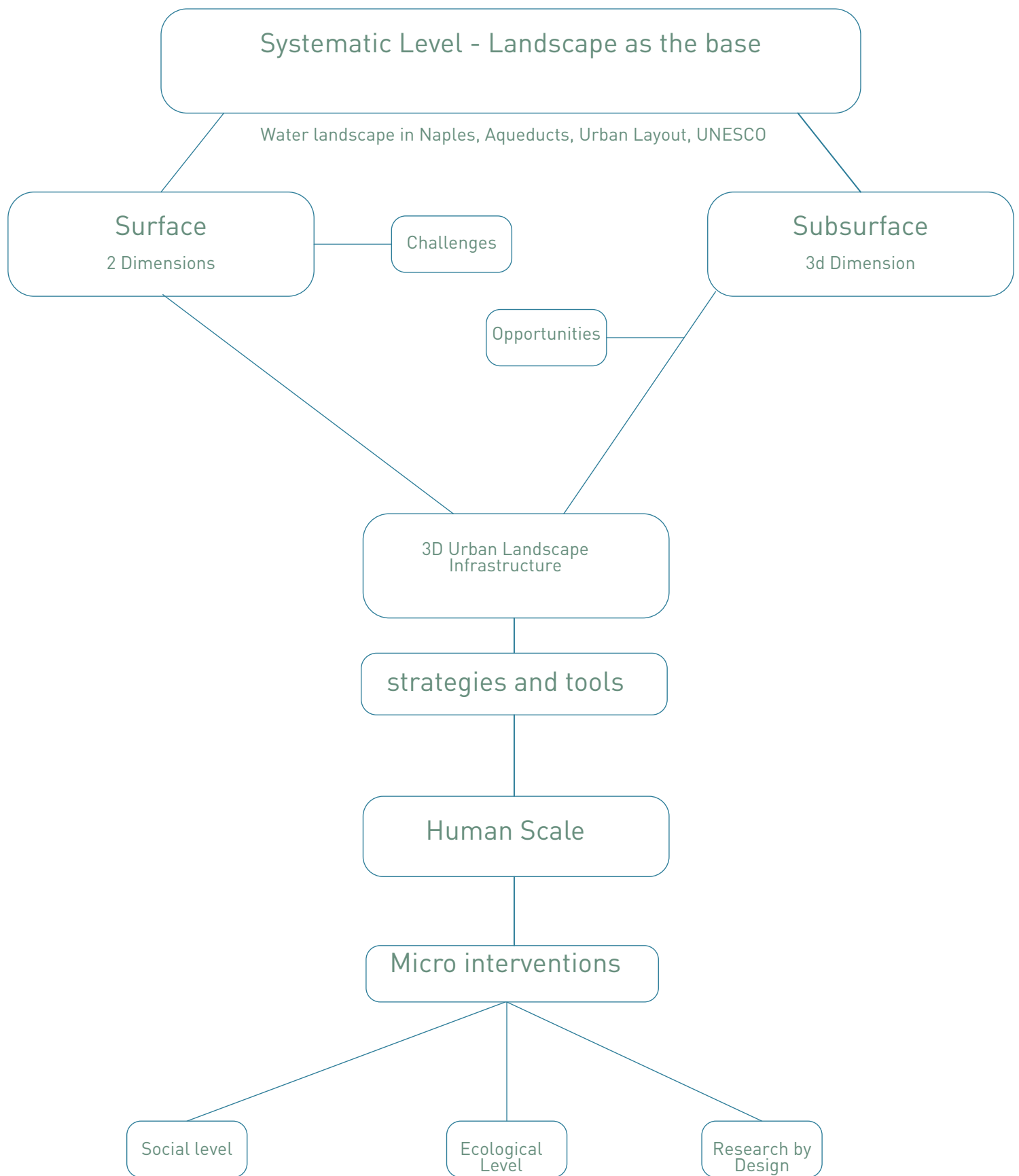


Fig. 10 Research Process

unregulated, and the Town Plan of 1999 fails to provide any practical recommendations for their use or integration with surface urban life (De Stefano, Di Pinto, Gerundo 2015).

As James Corner (1999) stated in *Recovering Landscapes as a Critical Practice*, it is crucial to have a reliable institution of responsibility, a mandate, for adaptive urban redevelopment:

“the lack of any power or group aimed toward the cultivation of landscape as an innovative cultural agent is unfortunate; such forces are much needed.”

Moreover, it is a chance to challenge the perspective of urbanists and architects in Naples. Whether in the sense that an urbanist is challenged to see the softness and changeability of a space and its infrastructures, making them aware of the fascination of every sub-space that will be influenced by their broader perspective on a big scale. They are challenged to see the public spaces with a certain compassion, optimism and eye for the detail. It is about raising awareness for the interconnectedness of elements and the opportunities that come along with it, when landscape seen as an infrastructure and vice versa. Same accounts for the architect, that is challenged to acknowledge the symbiosis between designed public spaces and the beauty of the built environment – that certainly flourishes more with a vivid and dynamic framing of an architected landscape around it.

2.6 Methods

To answer the research questions, the thesis combines experiential, historical, spatial, and analytical research methods. Mapping techniques are used on overall systemic level of the landscape as well as on the more detailed architectural level to identify the structure, presence and accessibility of the subterranean water system. Adding to it, analyzing the social circumstances, like living conditions within the city center of Naples, ground-floor use, and absent or present dynamics in relation to water, are contributing to the knowledge about what is needed in the public spaces. Insights gained through site visits and interviews with experts complement the desk study by observing informal use, narratives attached to the Neapolitan waters and the relationship between underground and surface elements. To contextualize the findings, precedent studies of UNESCO heritage cities with a (subterranean) water background like the subterranean Turkish city of Derinkuyu in Cappadocia, the city of Istanbul but also Tetouan (MAR) and Venice (IT) provide references on how water shapes public space, especially in compact, narrow and subterranean urban environments. The design phase is guided by looking at design references from Athens (GRC), Antwerp (BE), Utrecht (NL) and Pompeii (IT), translating all collected insights into a concept and design proposal for a subterranean-surface landscape infrastructure, aiming to enhance ecological performance, social cohesion, and spatial resilience. The approach is supported by digital methods like GIS-based mapping and layering to find out which areas of interest within the city center of Naples are crucial for landscape-based development. Finally, a reflective synthesis assesses the project's broader implications, limitations, and possible directions for future research.



Fig. 11 Regional Scale



Fig. 12 Locations within the city center of Naples

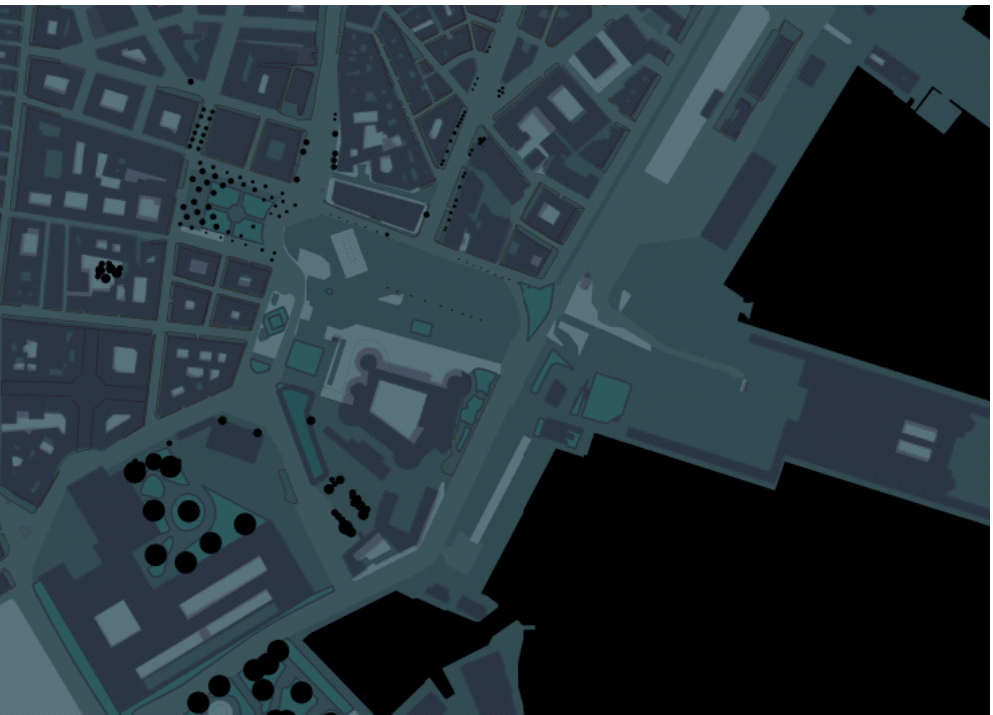


Fig. 13 Plaza scale

2.7 Research Design

In this project, the subterranean water system of Naples is studied and designed across three interconnected scales: On a regional scale (fig. 11) it is about the re-activation of the aqueducts, on an urban scale (fig. 12), strategies and a masterplan are being demonstrated, and on district to plaza scale (fig.13) the vertical movement of blue will be a driving force in the design details. At the regional scale, the research investigates the overarching hydrological infrastructure of the city, focusing on the historical aqueducts and their remaining physical traces within and beyond the city center. Through mapping, research on historical traces of water and spatial analysis, the water and aqueduct system is explored not only as a technical artifact but as a provider of hollow spaces in the underground that still holds potential to influence the public space.

At an urban scale, the study focuses on the city center of Naples, where challenges of spatial scarcity, climate vulnerability, and social inequality are most strongly felt. Through systemic analysis, the urban context is examined along multiple layers: tuff stone excavations that provide hollow underground spaces, aqueducts and cisterns that lie within the excavation structure, wells as the physical connector between underground spaces and surface and fountains and green spaces as surface-level elements. Public space typologies are being generated, strategies and a masterplan are formulated based on this layered understanding, aiming to reconnect fragmented public spaces through archaeology-sensitive design principles and establish a resilient and inclusive public space network including surface and underground level.

Finally, at the district scale, specifically in the area around Porta Capuana, design interventions are developed to make the vertical movement of blue, meaning water in a water abundant and cool air in a water scarce scenario, perceptible and experientially meaningful. Here, surface and subterranean elements are connecting each other through micro-scale spatial strategies that reveal the presence of underground water, enhance thermal comfort, and reconnect people with the city's hydrological heritage. These interventions form a three-dimensional landscape infrastructure where water acts as ecological system, social connector and climate mitigator.

The knowledge and design principles developed across these three scales come together to form a vision for climate-adaptive and socio-ecologically inclusive public spaces, driven by the landscape infrastructure being created through the interplay of the layeredness within the city center of Naples.

CHAPTER III

ANALYSIS



3

Naples on Regional Scale

Based on the understanding of Naples city center being reactivated through a water-system based landscape infrastructure, the overall outline of the water landscape that Naples is embedded in will be presented. Based on the regional water context, the following deepening chapters of the analysis follow the logic of the water and its connected landscape to guide the research process.

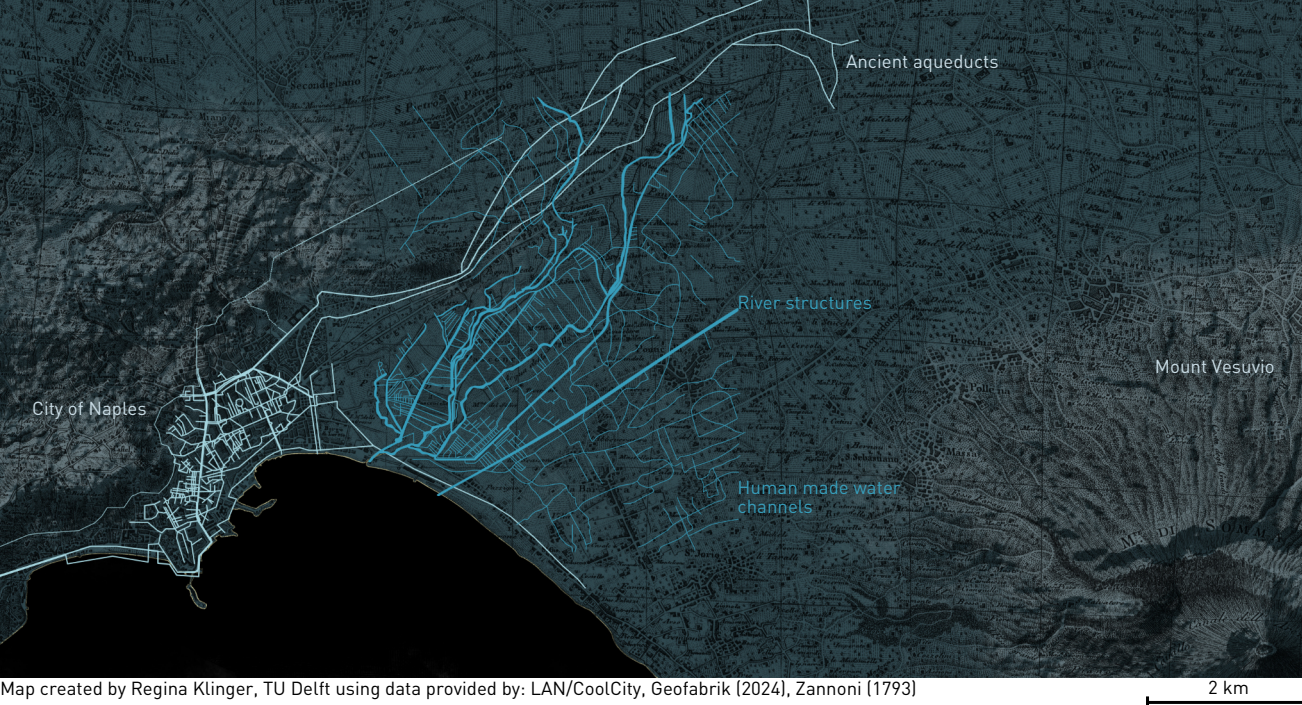


Fig. 14 Regional water landscape 1800 based on Zannoni map from 1793

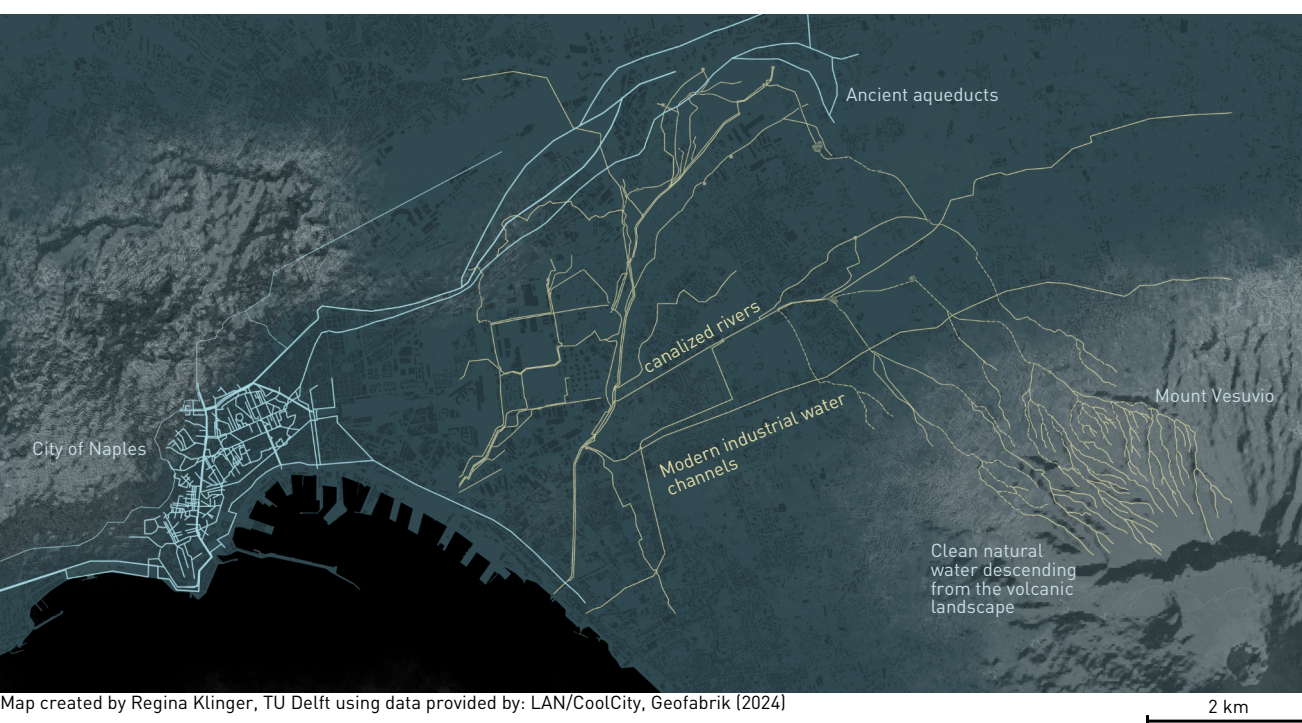


Fig. 15 Regional water landscape today based on today's elevation and city layout

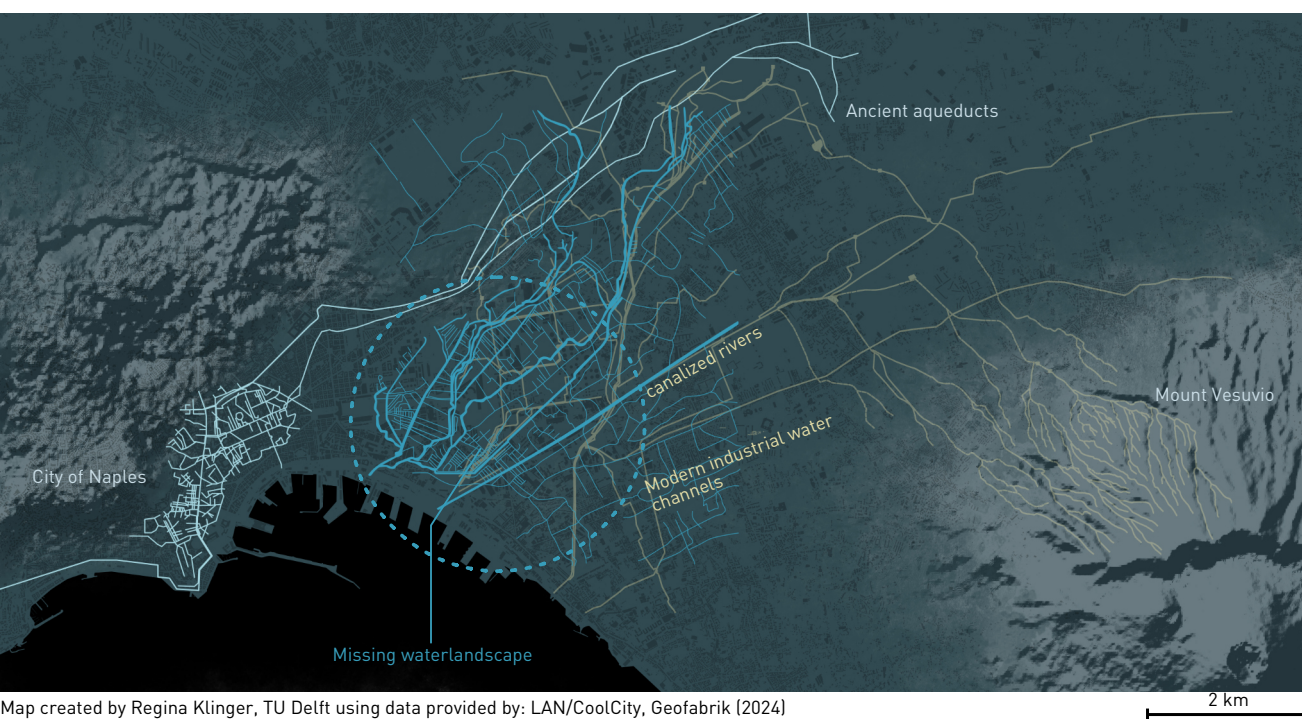


Fig. 16 Regional water landscape today lacking the binding value of the former water landscape between mountain and city

3.1 The Water Landscape and its history

The region of this South-Italian city used to be very connected to the water that runs around and beneath it and until today various narratives attached to the water system persist (Palestino, 2024). Especially the three different aqueducts – the Bolla, Serino and Carmignano aqueducts – played a crucial role in tapping the water sources around Naples and are also an essential connecting part of the subterranean structures. There used to be thousands of wells within the city of Naples providing water from the aqueducts to public spaces and private houses (Hydria Virtual Museum, n.d.).

There is a story line underlying the waters that flow towards, within and near Naples. It is connected to narratives about agriculture, thermal baths, economy, social interaction and healing (Palestino; Valentino, 2024). Understanding the stories and past conditions that water brought to the people and the city of Naples, helps to further understand how the design can reactivate or recreate certain images or narratives that create a reconnection towards the water heritage within the inhabitants' everyday lives. Consequently, it is crucial to understand what kind of stories are attached to the Neapolitan waters.

3.2 East Naples

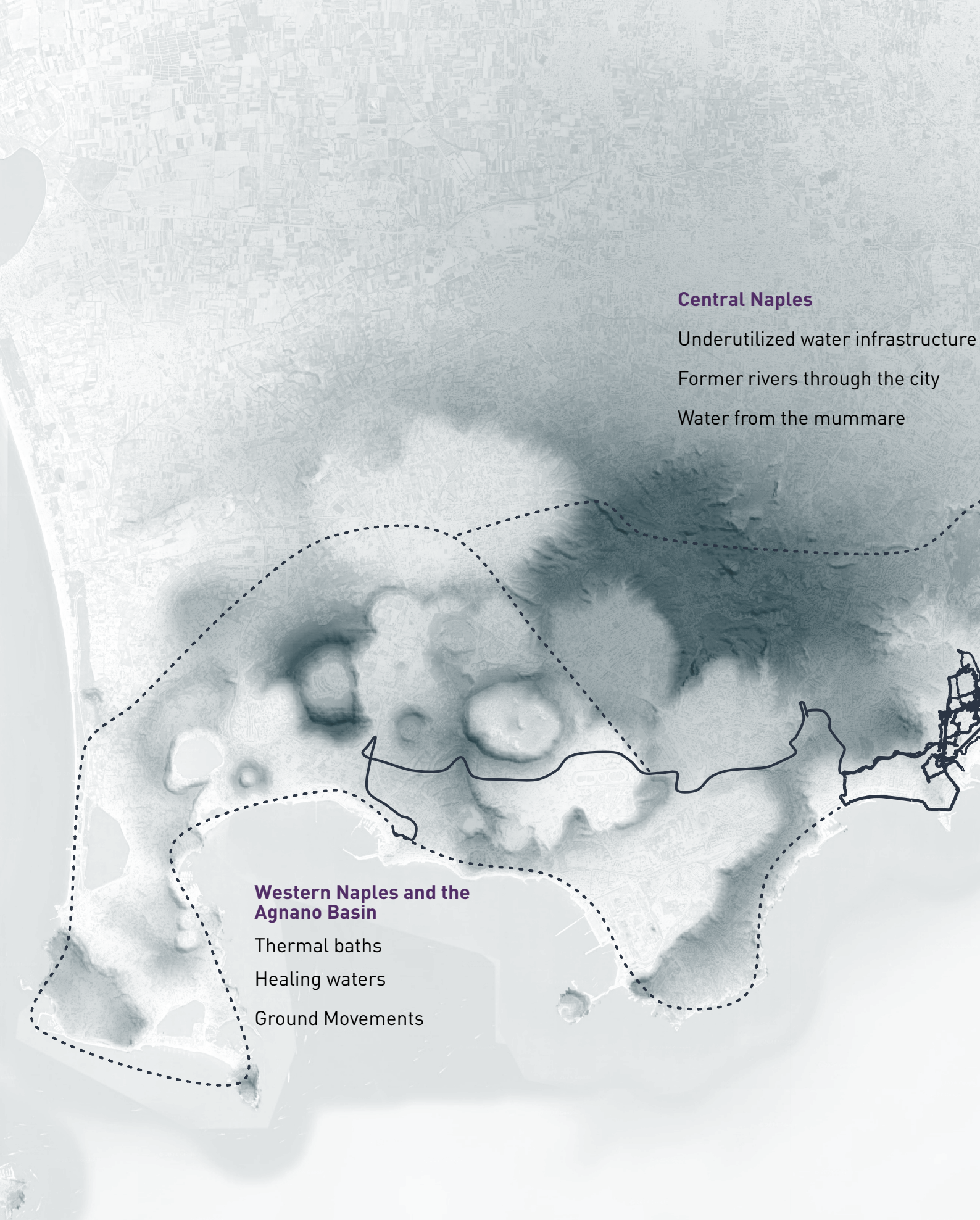
East Naples (figs. 14-17) holds one of the richest yet least visible hydrological landscapes in the city. Here, the convergence of rainwater through riverbed collectors and the presence of active groundwater flows form a complex system of subterranean abundance. The area hosts significant infrastructural nodes such as the Water House, the origin of the Bolla Aqueduct, and the Lufrano wells, drilled in the 1980s to tap deeper aquifers and supplement the Serino system. Historically, this water system powered the mills that once enabled East Naples' industrial development. While the former wetlands and dunes near the former bridge Ponte della Maddalena have disappeared, the underlying hydrological network remains largely intact beneath the surface (Palestino 2022; LAN/CoolCity, 2024). For this thesis, East Naples represents a critical starting point for the reactivation of water infrastructure as landscape, where groundwater pressure, historic aqueduct lines, and buried hydrological flows can be brought back into dialogue with surface design. It offers opportunities for public space cooling, water reuse, and micro-climate regulation, especially in a district lacking green open spaces and facing high climate vulnerability.

3.3 Central Naples

The central zone of Naples (figs. 14-17) is marked by a diverse and layered water history. From sulphureous springs and mummare – clay pots in which water was carried through the city as a societal practice – to the Chiatamone baths, Fontana del Gigante, and countless small wells and fountains, the city once depended on a rich surface and near-surface water culture. Historical records even mention the Luciani community in Santa Lucia, who earned their living by selling spring water. These elements, partially visible or memorialized through toponyms like largo, cupa, arena, cavone, reflect the former presence of water. For the thesis, this area serves as a site of symbolic reconnection, where the memory of water infrastructure can be translated into design interventions that foster identity, social gathering, and spatial meaning. Water can here become a spatial language that reclaims streets and squares from over-commercialization, connecting deeply with Naples' cultural landscape. (LAN/CoolCity, 2024)

3.4 West Naples

The Agnano Basin (fig. 17), embedded within the Phlegraean Fields volcanic system, represents the thermal and geological counterpoint to East Naples. The collapse of the caldera gave rise to Lake Agnano and eventually revealed over 70 distinct springs, ranging from low-temperature mineral sources to geothermal waters reaching 80°C. Though the lake was



Central Naples

Underutilized water infrastructure

Former rivers through the city

Water from the mummare

Western Naples and the Agnano Basin

Thermal baths

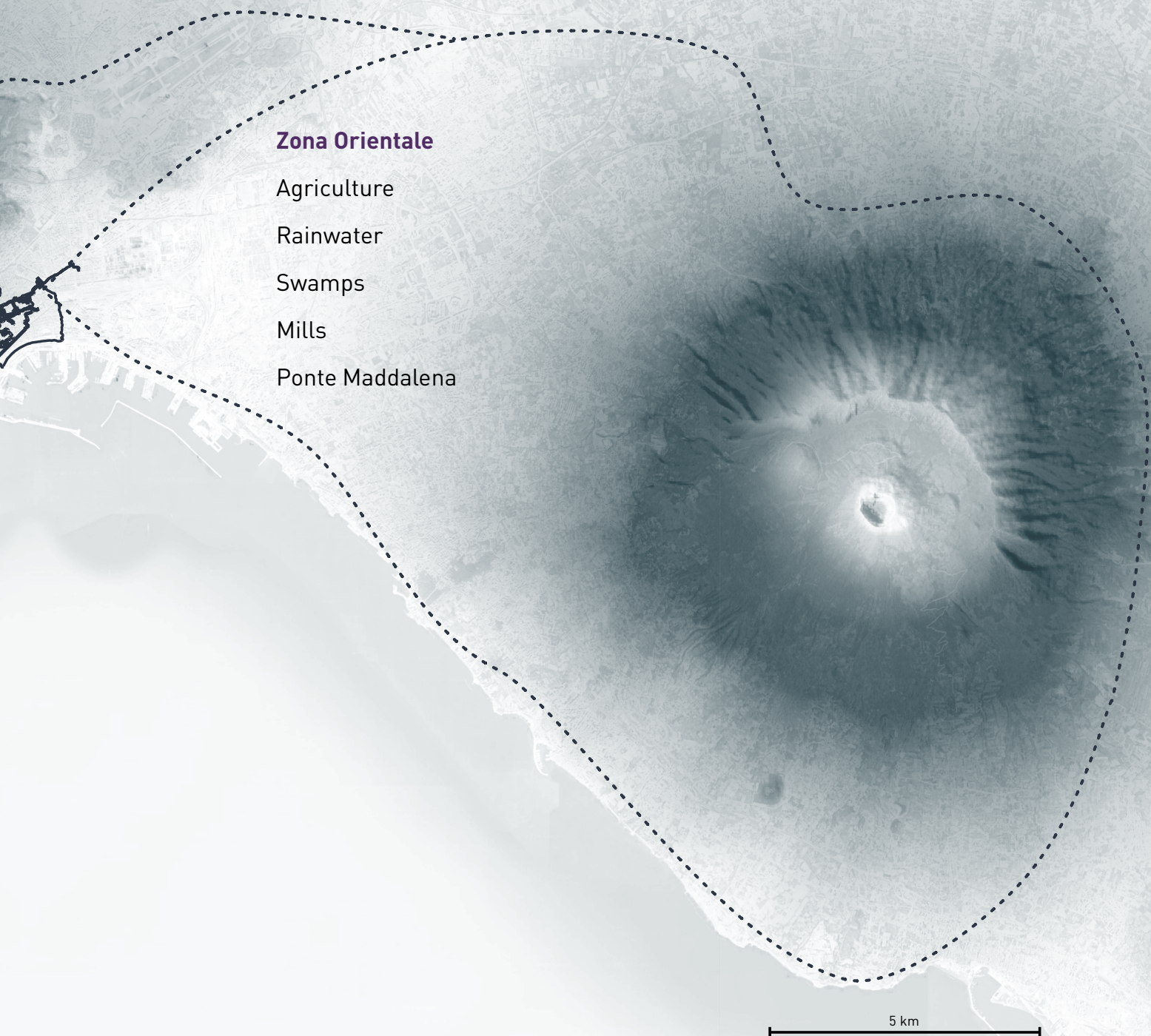
Healing waters

Ground Movements

Fig. 17 Area covered and stories collected during the site visit in December 2024

Map created by Regina Klinger, TU Delft using data provided by: Strava (2024)

drained in the 19th century, the subterranean thermal flows remain active. (LAN/CoolCity, 2024) From the thesis perspective, the western zone offers insight into hydro-geological dynamics and the potential for integrating ecological and thermal water systems. These can inform climate-adaptive strategies such as subterranean climate shelters, humidity-based vegetation corridors, and passive geothermal cooling. While it may not be the core design area, its processes offer applicable lessons for surface-subsurface synergy in more constrained parts of the city. (LAN/CoolCity, 2024)





4

Naples' city center at the Human Scale

From an eye-level perspective, there are many elements featured in Naples' public spaces. As stated in the introductory part of this thesis, it is to find out how better public spaces can be designed including surface-level and subterranean spaces along the line of a water-derived infrastructure. In order to answer this question in the design, it is important to understand the details of the subterranean excavation spaces, the aqueducts and cistern spaces as well as the surface features of the architectural features and green elements.

In the following chapter, the main landscape structures, public spaces typologies, their characteristic elements and performance will be drawn up.



Fig. 18 Exhibited part of the Serino aqueduct at Chiaia metro station
(Source: Alexander Valentino LAN/ CoolCity)



Fig. 19 Excavated water channels and passage ways
(Source: Hydria Virtual Museum, n.d.)

4.1 Main structures

The water system serves as the backbone of the design, consequently the main structures are being analysed in relation to it. To start with, the aqueducts that are still reportedly remnant in Naples and could potentially be revived as the basis of the future design are the excavated human-size channels of the Bolla and Carmignano aqueduct. The Serino aqueduct (fig. 18) got destroyed by volcanic activity and got replaced by smaller tubes, meaning it does not provide relevant spatial units to work within the range of the city center and will be left out for this thesis. Not all parts are actively providing water anymore, so there are only few spots that reportedly run water within the aqueduct structure, as for example the Lapis Museum in the city center that showcases the cisterns with light installations. The water itself is present in the underground but is running through the city uncontrolled, which causes sinkholes in some spots. Re-activating the aqueducts could potentially give back control over the water again.

4.2 The Aqueducts

The first aqueduct, that mainly fed the city center of Naples, is called the Bolla Aqueduct and was built around 400 BC, feeding the city over two thousand years. It tapped the zona orientale, the area east of Naples and brought water from the area in 10km distance which included the ancient town Volla and its swampy plain and mount Vesuvius. These plains could exist as they were closed off from the sea through former dunes along the coastline. This former area of swamps also provided water to the former river Sebeto.

The Bolla Aqueduct then got strengthened and later replaced by the Serino Aqueduct. Built between 30 and 20 BC during Emperor Augustus's reign, the Serino Aqueduct, also known as Aqua Augusta, was a monumental engineering element. It spanned approximately 100 kilometers, sourcing water from the Apennines near Serino and supplying multiple cities, including Naples, Pompeii, Herculaneum, and the naval base at Misenum. The aqueduct's route included complex tunnels and bridges but mostly fed the richer population along the coastline. (Hydria Virtual Museum, n.d.)

The Carmignano Aqueduct was introduced in the early 17th century to address the water shortages that followed the city's explosive population growth and the breakdown of older systems. Drawing from springs on the slopes of Mount Vesuvius, it supplied many of Naples' institutional buildings, including the Royal Palace, through a mix of underground channels and above-ground arches. Though built centuries later, the Carmignano system reused and intersected earlier routes, especially those of the Bolla, creating a dense vertical mesh of overlapping hydraulic layers beneath the modern city. Remnants of this aqueduct are still visible today and accessible in parts of the urban environment. (Hydria Virtual Museum, n.d)

Together, these three aqueducts form a subterranean infrastructure, of which only the Bolla and Carmignano aqueducts are still present as spatial subterranean structures. The spatial logics, from linear channels to punctuated access points in the form of wells, inform the core concept of Vertical Blue: the reactivation of subterranean water systems not as isolated single-purpose remnants, but as structuring spatial elements for a new type of socio-ecological and climate-adaptive public spaces. Re-engaging with these systems means uncovering more than just water by revealing opportunities for microclimatic cooling. It also means bringing back the water-mindset to the people, social reconnection, and vertical layering in the ancient city of Naples.



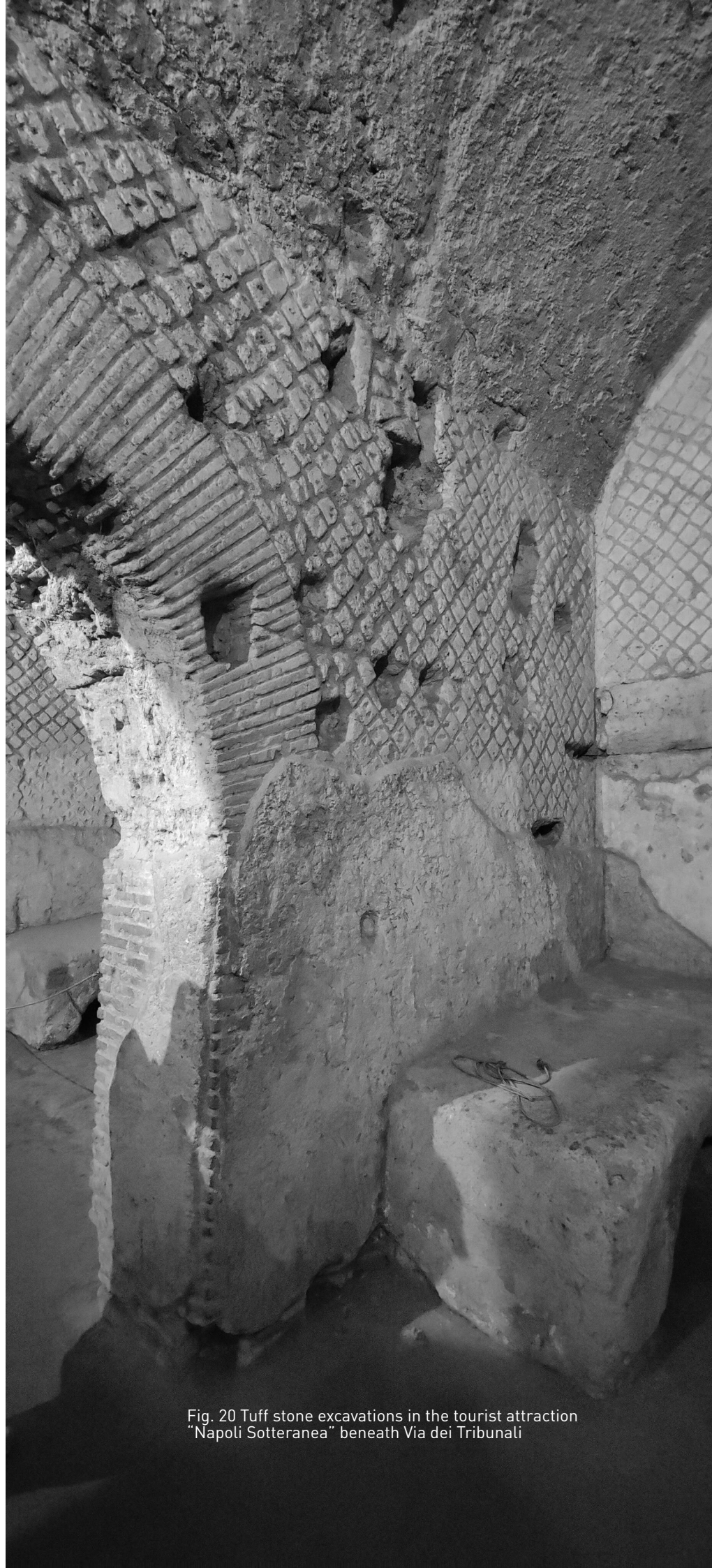


Fig. 20 Tuff stone excavations in the tourist attraction
"Napoli Sotteranea" beneath Via dei Tribunali



Fig. 21 Public space situation at the northern entrance point to the tourist attraction “Napoli Sotterranea” in Piazza San Gaetano

Fig. 22 Public space situation at the southern entrance point to the tourist attraction “Napoli Sotterranea” in Piazza San Gaetano





Fig. 23 Via dei Tribunali - the sign is the only indicator for the subterranean spaces lying beneath the surface

4.3 Tuff stone excavations

The tuff stone excavations (figs. 18; 19; 20) in the city center provide different kinds of spaces that could be turned into public space structures. There are the underground channels and stairways on human scale as they were dug out by hand and had to be walkable for maintenance. They measure around 2 meters. They connect the wider excavated spaces with each other. The wider spaces generally provide potential for actual social cohesion.

Some spaces, like the Lapis Museum, the tourist attraction Napoli Sotterranea (figs. 20-23) and Galleria Borbonica but also some exhibition and wine storage spaces are some of the functions in the underground spaces.

According to De Stefano, Di Pinto and Gerundo (2015) there are several possible categories of artificial excavations which include tombs and places of worship, rain tanks, aqueducts, tuff caves, lapillus and pozzolana caves and tunnels and walking caves.





Fig. 24 Underground structures exposed to the Public Space Structures

Map created by Regina Klinger, TU Delft using data provided by:
Google (2024), LAN/CoolCity, Geofabrik (2024), Manuel Orabona, Istat (2011), UNESCO, Comune di Napoli (1967)



Carmignano Aqueduct
Bolla Aqueduct

Spaccanapoli (Decumano)

Via Duomo (Cardo)

1km

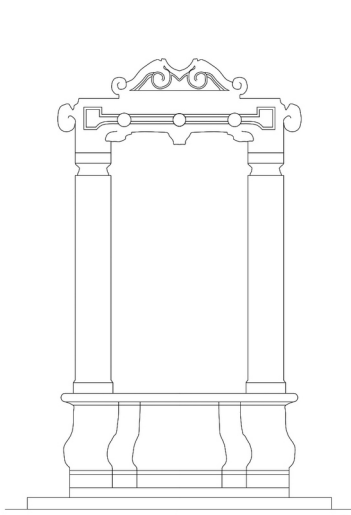


Fig. 25 Via San Sebastiano 28

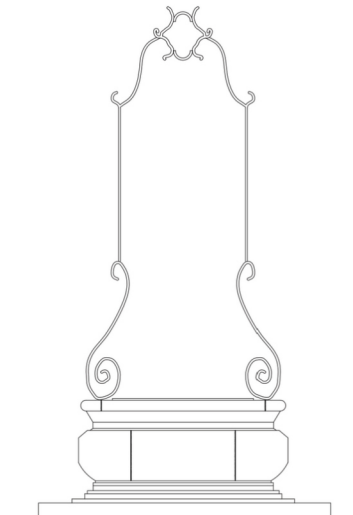


Fig. 26 Basilica dello Spirito Santo, Via Toledo

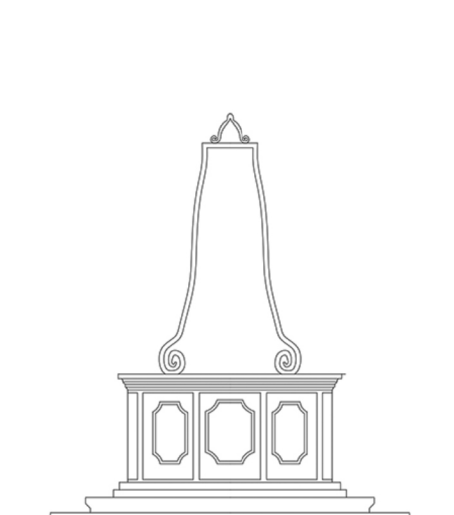


Fig. 27 Santa Maria di Monteverginella, Via Giovanni Paladino 21

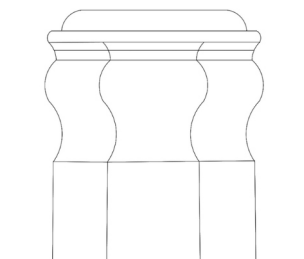
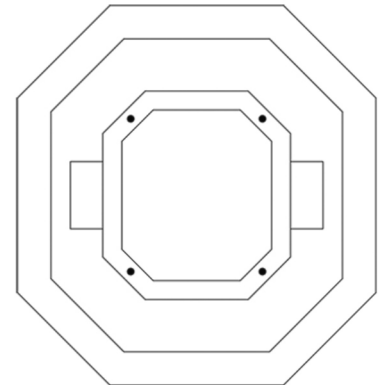
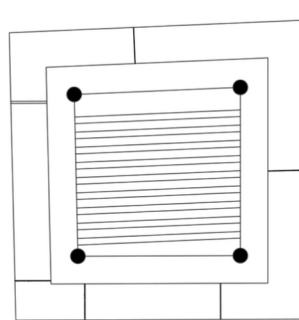
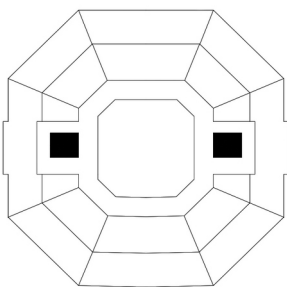


Fig. 28 Pozzo dei Pazzi, Ospedale dei Incurabili

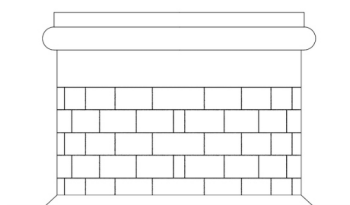


Fig. 29 Palazzo Acquaviva

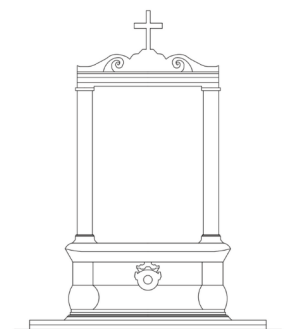
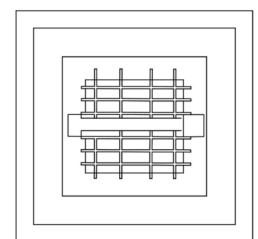
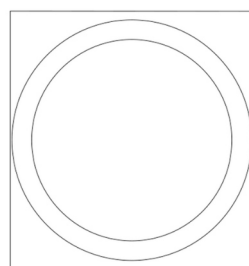
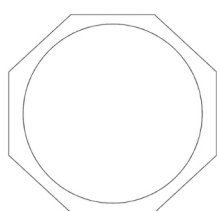


Fig. 30 Chiostro minore di Santa Maria la Nova



4.4 Wells - “Pozzi”

The wells play an important role in the physical accessibility of the underground water system. Their main function was to access the aqueducts' and cisterns' water that was brought up by hand using baskets and so called mummare, which are clay amphoras.

In the 19th century there were still more than 4500 wells existing, which made it possible to access the underground world. Oftentimes equipped with ladders and steps, these openings on the surface were crucial for everyday life in Naples. They provided fresh water for residential use and therefore maintained public hygiene, health but also urban public and private green. (Hydria Virtual Museum, 2024) From the many thousand wells, only a few are still accessible or mapped, as urbanization processes and newer water infrastructure replaced the wells and led to their disappearance. It is therefore difficult to trace back the exact number of still existing wells and to define how many of these micro-portals to the underground are in good condition. In general, every bigger residential unit used to be equipped with its own well. The still existing wells are however as diverse as the city of Naples and reach from minimalistic functional architecture elements to ornamental engravements that even tell stories through time. (LAN/CoolCity, 2024)

There are stories attached to the remaining wells in the city. Not all their stories could be traced back, but a collection of stories will be presented, referring to the research of laboratorio architettura nomade and their initiative CoolCity, who collected stories and photogrammetry data of these spaces and their vertical connections.

Pozzo dei Pazzi (Well of the Mad) – Hospital of the incurables

This well (fig. 28), located in the courtyard of the historical pharmacy of the Incurabili complex in the North of the city center, was used for unconventional psychiatric treatment of incurable people during the 17th century. Mentally ill patients were lowered into its 40-meter depths, where the cold and isolation were thought to bring the patients to their senses. Even though it has a disturbing background, the well's verticality and microclimate presents an atmospheric opportunity to reactivate the space with a cooling void within the city's climate adaptation network. By transforming this well from a space of exclusion to one of wellbeing and reflection, the idea of Vertical Blue – letting cooling water and air move from the underground up – gives new purpose to hidden heritage while sensitively reuse the spaces in a new way.

Palazzo Acquaviva – Via Atri

In the garden of a historic residence lies a well (fig. 29) that connects to an ancient Roman cistern system beneath Via Atri. The circular and plastered chambers with drainage mechanisms reflect a highly developed water infrastructure. These subterranean spaces exemplify how the rediscovery and integration of Roman engineering into contemporary urban design can strengthen strategy of vertical reconnection. This well, embedded in a semi-public setting, could act as an anchor point for future access or climate buffer zones, especially within courtyard typologies.

Chiostro Minore – Santa Maria la Nova

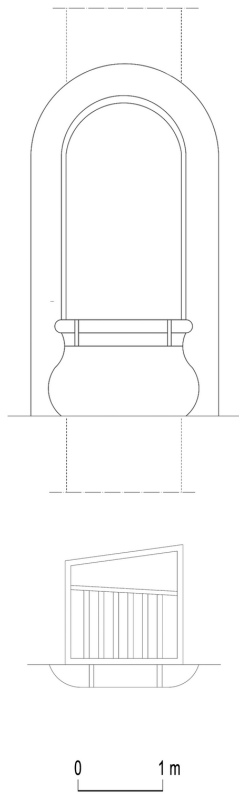
Above the Monteoliveto canal, this complex holds two lush, functioning wells (fig. 30) that have fallen into neglect and misuse. Historically linked to the contemplative rhythm of the cloistered order, these wells once were part of calm interior landscapes. Their decay talks about the loss of spiritual and environmental functions in modern urban life. The remnants of these wells



Fig. 31 Well that releases constant cool air from beneath the surface at the cloister Chiostro di San Gregorio Armeno in Via S. Gregorio Armeno



Fig. 32 Well at
Basilica dello
Spirito Santo
behind the
Department of
Architecture
Università degli
Studi di Napoli
Federico II
Via Toledo



Via Atri 3

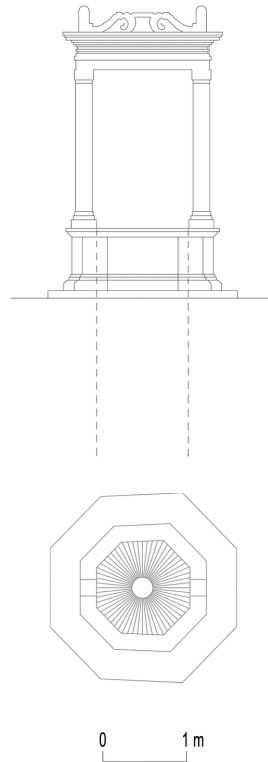


Fig. 33 Chiostro minore San Paolo Maggiore

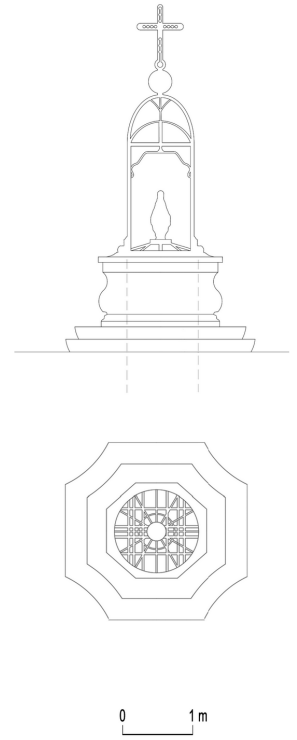


Fig. 34 Chiostro del pio monte della Misericordia, via dei tribunali 253

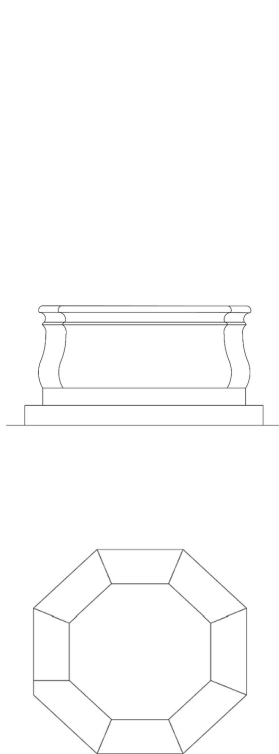


Fig. 35 Complesso Monumentale di Santa Maria della Pace e Lazzaretto, via dei tribunali 226

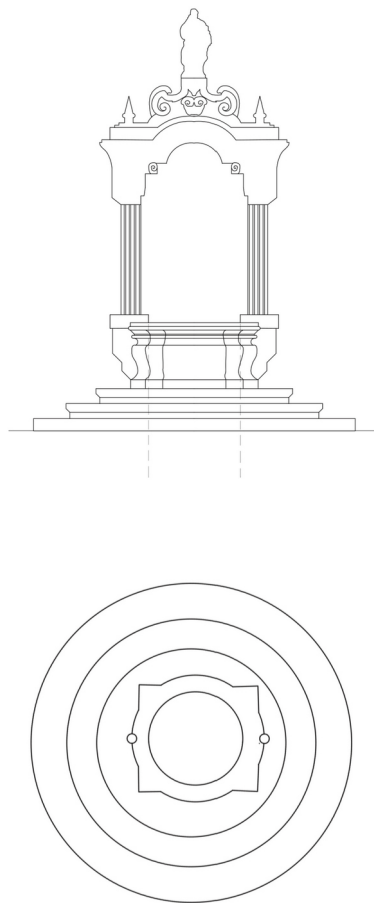


Fig. 36 San Lorenzo Maggiore piazza San Gaetano

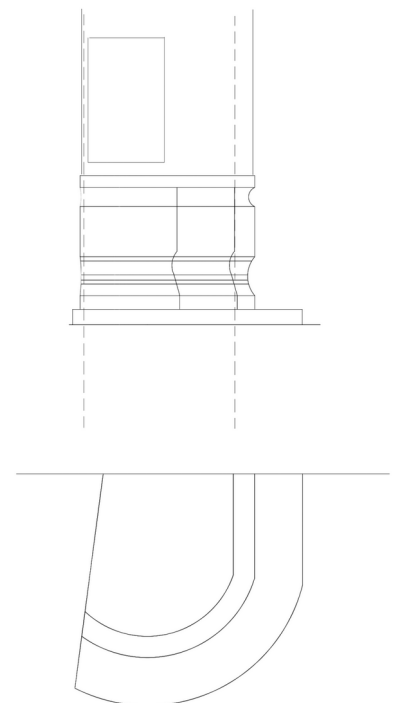


Fig. 37 Palazzo Petrucci piazza San Domenico maggiore 3

1m

have the potential to be restored and create historic harmony between water, silence, and reflection by reintroducing soft water features and vegetation into these cloister spaces.

Chiostro Minore – San Paolo Maggiore

This cloister hosts an octagonal marble well (fig. 33) supported by granite columns, a refined composition once used to draw water. The centrality and ornamentation of this well demonstrate how water was not only functional but also ceremonial. Such spaces can act as both orientation points and microclimate hubs. They can bridge ornamental tradition and contemporary spatial needs, offering moments of rest and social encounter within dense urban patterns.

Pio Monte della Misericordia – Via dei Tribunali

The well (fig. 34) located in the courtyard of an art museum was historically associated with providing water to the poor. Here, charity and public health intersected with infrastructure. Reviving such sites speaks directly to the socially inclusive dimension of the Vertical Blue approach. Integrating access to water and shade in spaces strengthens the proposal's commitment to climate justice and equal access to quality public spaces.

Santa Maria della Pace e Lazzaretto

This well (fig. 35) lies within a church and hospital complex where infectious patients were treated in isolation. The presence of a well here shows the role of water in spatializing health, separation, and purification. These principles are central to the climate shelter strategy, as subterranean voids are reconsidered as safe, breathable, and accessible places of rest, clean water and retreat.

San Lorenzo Maggiore

San Lorenzo Maggiore adds a Gothic layer to Naples' complex architectural heritage. This cloister well (fig. 36) is richly decorated, suggesting that water and its access points were integrated into spiritual and artistic expression. These elements offer inspiration for new interventions along the Vertical Blue corridor that holds potential to unite heritage detailing with thermal and acoustic functions, transforming wells into sensory and spatial markers.

Palazzo Petrucci

This aristocratic residence once connected banking, religion, and art. The well (fig. 37) in its courtyard is an example of private wealth and public symbolism coexisting next to each other. The reintegration of such spaces into the city's broader network of green, breathable and accessible public space suggests a method of reclaiming exclusive spaces for collective benefit.

Palazzo Filomarino della Rocca

This palazzo is historically tied to revolutionaries and philosophers. Though less is known about the physical well (fig. 39), its setting invokes values of independence, knowledge, and transformation. The well can be reimagined as a portal to Naples' invisible layers of resistance, offering a mental connection between spatial heritage and new narratives of civic empowerment through design.

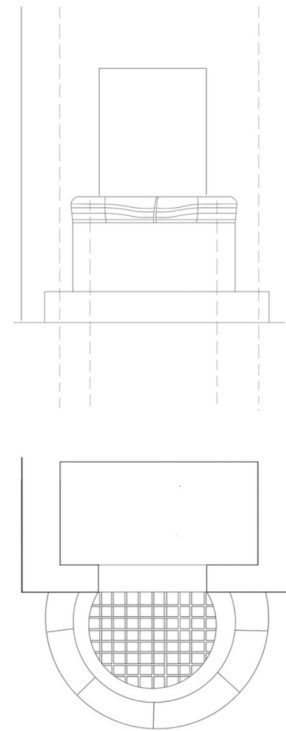
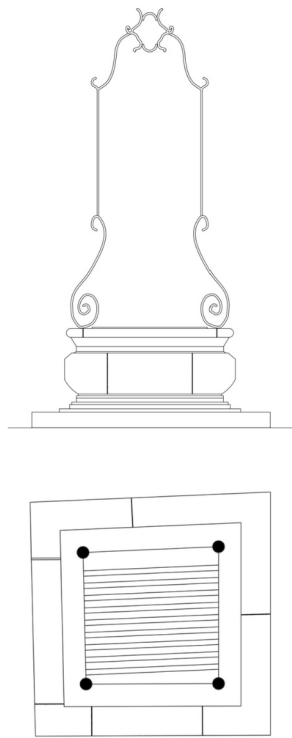


Fig. 38 Basilica dello Spirito Santo
behind the Department of
Architecture Università degli Studi di
Napoli Federico II

Fig. 39 Palazzo filomarino
della rocca via benedetto
croce 12

Via Toledo



Fig. 40 Fontana della Scapigliata



Fig. 41 Fountain Capone

Basilica Spirito Santo – Via Toledo

In the backyard of the department of Architecture at University Napoli Federico II, located at the junction between Greco-Roman Neapolis and Renaissance Naples, this spatially strategic location opens a window towards the busy streets of via Toledo, where it can showcase how water systems and city-making once coexisted seamlessly. Currently being used as a parking lot, neglecting the existence and potential of this well (figs. 32; 38), a revival by threading the aqueducts into contemporary public space structure again would be feasible there. This well gets the opportunity to become an educational space, a dialogue between architecture and subterranean landscape and at the same time can function as a socio-ecologically valuable open space.

Santa Maria di Monteverginella

This cloister well has both religious and legendary significance. During World War II, an aerial bomb landed in the courtyard without causing harm, a miracle attributed to the Virgin Maria. The well, as spatial and spiritual center, became part of this survival narrative. Reintegrating these wells via vertical activation draws from such stories to frame underground and courtyard spaces as protective zones where resilience is made tangible, both in thermal and symbolic ways.

(LAN/CoolCity, 2024)

4.5 Fountains

The fountains of Naples are more than ornamental objects. They are points where the hidden water infrastructure becomes visible and public. Each fountain carries its own story, shaped by changes in use, maintenance, location and meaning over time. In this thesis, fountains are used as narrative and spatial anchors that help to reconnect mentally to the relationship between surface and underground, past and present. They mark the places where water once emerged, was stored or shared, and where people gathered to wash and chat. By focusing on their individual histories and conditions, the project highlights how these elements can guide a re-reading of the city's water structure while accentuating narratives attached to the public space they are placed in. This approach also recognizes fountains as social spaces where water shaped public life in ways that remain relevant for design today.

A selection of fountains across Naples' city center will be presented in the following sections.

Fontana della Scapigliata

This water running fountain (fig. 40), once known as the 'Scompigliata' for its wild water jet, was a functional and symbolic element of civic water culture during the viceroyal era. Built between 1539 and 1541 under Giovanni da Nola, it marks a historical layering of utility and ornamentation. Its present-day partial restoration suggests the potential of Naples' fountains to reconnect with their original social and acoustic presence within the public realm. Next to it, there is another fountain, that of Capone (fig. 41) which is today, through a conservative restoration, the structures have returned to their former state but not the water function. (Wikipedia, 2025, January 5)

Fontana della Sellaria



Fig. 42 Fontana della Sellaria



Fig. 43 Fontana della Spinacorona



Fig. 44 Fontana del re Carlo II

This fountain runs water as well (fig. 42). Constructed between 1649 and 1653, this fountain was a political statement after the Neapolitan Republic led by Masaniello. It was funded by local residents and executed through a collaborative craft effort under architect Onofrio Antonio Gisolfi. The fountain stands as an embodiment of civic agency and collective memory, touching upon the thesis' aim to revive local identity through water infrastructures. (Wikipedia, 2025, January 5)

Fontana della Spinacorona

This fountain (fig. 43), also known as delle zizze, stands next to the Church of Santa Caterina della Spina Corona. Its mythological sculpture of the siren Partenope cooling Vesuvius with water from her breasts has deep cultural resonance, connecting beauty, danger, and water as the protector. Originally dating back to the 15th century and redesigned in the 16th century, the fountain is a powerful symbol of Neapolitan myth, heritage, and water symbolism. (Wikipedia, 2025, January 5)

Fontana del re Carlo II

Fontana del Re Carlo II (fig. 44) constructed between 1668 and 1673, this monumental fountain features a three-armed polylobate basin crowned with a bronze statue of Charles II of Spain. Supported by lions and eagles holding coats of arms, the design merges political power with water symbolism. Located in Piazza Carlo III, the structure reminds us how fountains once carried messages of rule and resilience, while today it represents an opportunity to revalue majestic heritage spaces as part of the city's cooling infrastructure. In 2013, the fountain underwent restoration due to partial collapse of the support structure caused by neglect, however it is now a fenced-off, garbage-exposed sculpture without water function. (Wikipedia, 2025, January 5)

Fontana della Marinella

According to Wikipedia (2025, January 5) the fountain (fig. 45) was commissioned after the 1781 fire in Piazza Mercato by King Ferdinand IV and built by Francesco Sicuro, this fountain was moved several times before reaching its current location. The structure suffered neglect and partial loss but is now under restoration. Its fragmented history reflects the instability of many Neapolitan water elements and the urgent need for reintegration of such pieces into the public consciousness and design.





Fig. 46 Micro Green elements within the traffic of Naples with view to the west towards Castel Sant'Elmo



Fig. 47 Former traces of existing tree plantations



Fig. 48 Collective backyard with neglected wild green structure that provides ecological value

4.6 Green spaces

Towards the city of Naples, the more continuous and generous green structures from the elevated hillsides including Bosco di Capodimonte in the North, Parco del Poggio di Capodimonte in the North-West and Parco Urbano dei Camaldoli in the West stop abruptly because of urban expansion happening over time. On the way towards the city center, only two bigger green structures can be identified: the vineyards of San Martino to the West and the Orto Botanico di Napoli to the North-East of the city center. Both of them represent relics of former large-scale green systems which are now fragmented and isolated from each other, supporting Aveta's (2012) concern that green space in Naples has historically been reduced to residual and enclosed plots.

By entering the city center, there is hardly any publicly accessible green space perceivable (fig. 46). Mostly there are singular trees or tree lines present that however do not connect to another green space. The greenest areas of public urban green in the city center lie around the alley Via Santa Maria di Costantinopoli with the pocket park of Piazza Bellini attached to it in the North-West of the city center. At the south-western border to the city center a combination of two alleys and a pedestrian zone within Via Miguel Cervantes de Saavedra and Via Guantai Nuovi are marking another perceptible and soothing green infrastructure between Piazza del Municipio and Piazza Giacomo Matteotti. These fragments reflect Aveta's identified need for a connective system of interconnected green that supports continuity within the dense city core.

Within the city center lies a hidden layer of green spaces. These are the hidden green spaces, partly public, partly collective (fig. 48) to private. One of these hidden green spaces are traditional gardens, highly maintained and oftentimes inaccessible for the public. For instance, the garden of the cloister complex Chiostro di San Gregorio Armeno is accessible through payment but therefore not a public resource. These gardens represent a heritage of spatial, cultural, spiritual and ecological relevance. Aveta emphasizes that the typology of hortus conclusus - inward-facing and walled green sanctuaries - formed the core of Naples' historic green infrastructure, shaped by cloisters, religious insulae and aristocratic residences. They were used for contemplation, medical practice and food cultivation, defining a green logic specific to Naples.

Over centuries, this green matrix has suffered due to speculative urban development, turning many former green plots into built surfaces (fig. 47), undermining ecological balance and spatial identity. Despite this erosion, Naples still retains an extraordinary number of historic green sites - particularly cloister gardens - that hold potential as anchors in a reimagined urban ecology. These spaces are characterized not only by their botanical heritage but also their value as spatial tools of urban resilience and memory.

These findings underscore the need to reframe these gardens not as isolated historical relics, but as an active network of climate-responsive micro-spaces. Gardens such as those in monasteries and palazzi still exist, though often obscured or underused, reinforcing the relevance of reactivating them within a larger strategy for socio-ecological inclusion. Their reprogramming could bring new value to courtyards and voids, shaping shaded, breathable, and culturally rich zones in the urban tissue.

Aveta calls for the regeneration of degraded urban areas through green inserts - micro-parks, public cloisters, and adaptive reuse of residual gardens. This supports the ambitions of this thesis to reintegrate these spaces as functional components of a multi-dimensional landscape infrastructure.

In conclusion, Naples' green typologies - from cloister gardens and aristocratic plots to spontaneous greenery along infrastructural voids - must be reactivated not merely for aesthetics, but for their potential to restore ecological balance by providing microtopes and shading features, social equity, and cultural continuity in the dense historic center.

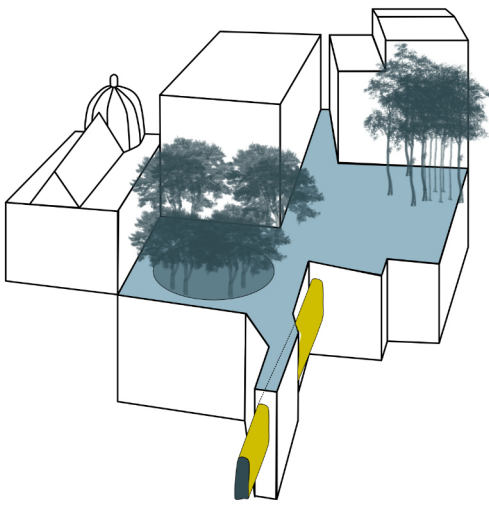


Fig. 49 Public Space
Largo S. Giovanni Maggiore

Publicly accessible space

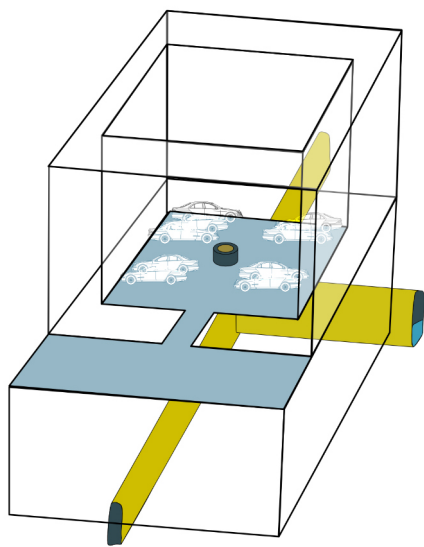


Fig. 50 Collective Space
Dipartimento di Architettura - Università degli Studi di Napoli Federico II

Publicly accessible space, dominantly used by a certain user group

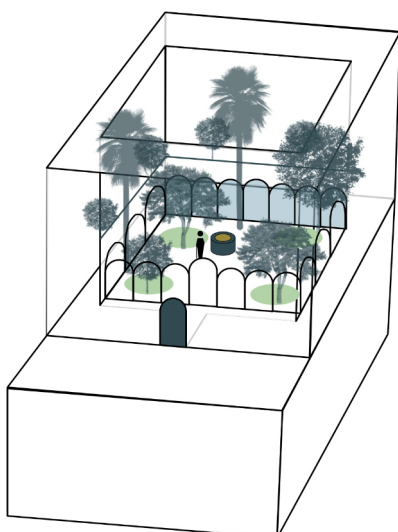


Fig. 51 Private Space/ Hidden Public Space
56 Chiostro di San Francesco

Inaccessible (public) space

4.7 Synthesis of all these findings: Public Space Typologies

In order to draw out the different public space typologies, it is important to understand which public spaces are located along the subterranean water system. Through a layering technique (fig. 53), all the thesis-relevant layers of excavations, water infrastructure, architectural elements and green structures, will be overlapped with the mapped public space units of Naples inner city. Then, public space typologies will be generated. The findings will then define which public spaces to focus on in the vision and in the design process.

The city center of Naples consists of three different kinds of spaces that the water and excavation systems run through: Public space (fig. 49), collective space (fig. 50) and private space (fig. 51). The latter seems to inherit most of the green spaces and connections to the subsurface.

Many public spaces are characterized by highly sealed surfaces, a compact layout and informal commercial use where green structures oftentimes were just a disconnected side-product to the scene. It seems that integrating any landscape-architectural features is impossible. However when looking at their subterranean features, like the constellation of excavations and water juxtaposed to wells, fountains and green structures, they start to differ from each other and problems start to get answers through the infrastructural features of the subterranean landscape (fig. 54; 55).

This typological reading does not follow formal logic alone. It is grounded in the spatial, climatic and historical potential of each site. As argued by Nijhuis and Jauslin (2015), infrastructure can become an operative landscape structure when it engages with ecological and social processes at once. This understanding supports a different perspective on public space in Naples. Rather than adding new elements on the surface, the project reads the existing spaces as thresholds. Each type represents a different capacity to reconnect with the underlying system and thus gain new spatial meaning and function.

The typologies are not fixed categories, as they rather are starting points for design that responds to the city's complexity. Public space in Naples is not a neutral container, but a palimpsest of water heritage, social activity and climatic challenges. In line with the work of Zhang, Nijhuis and Newton (2022), the presence of water in public space offers

not only ecological services, but also contributes to social and psychological well-being in forgotten and neglected parts of the city center. This becomes particularly relevant in a city where climatic stress and tourist pressure affect daily life in public space (Esposito, 2023). By recognizing the hidden potential of the places within the center but also identifying new qualities within off-key areas, new perspectives for the inhabitants' outdoor spaces but also the experience for the visitors of the city can be set up.

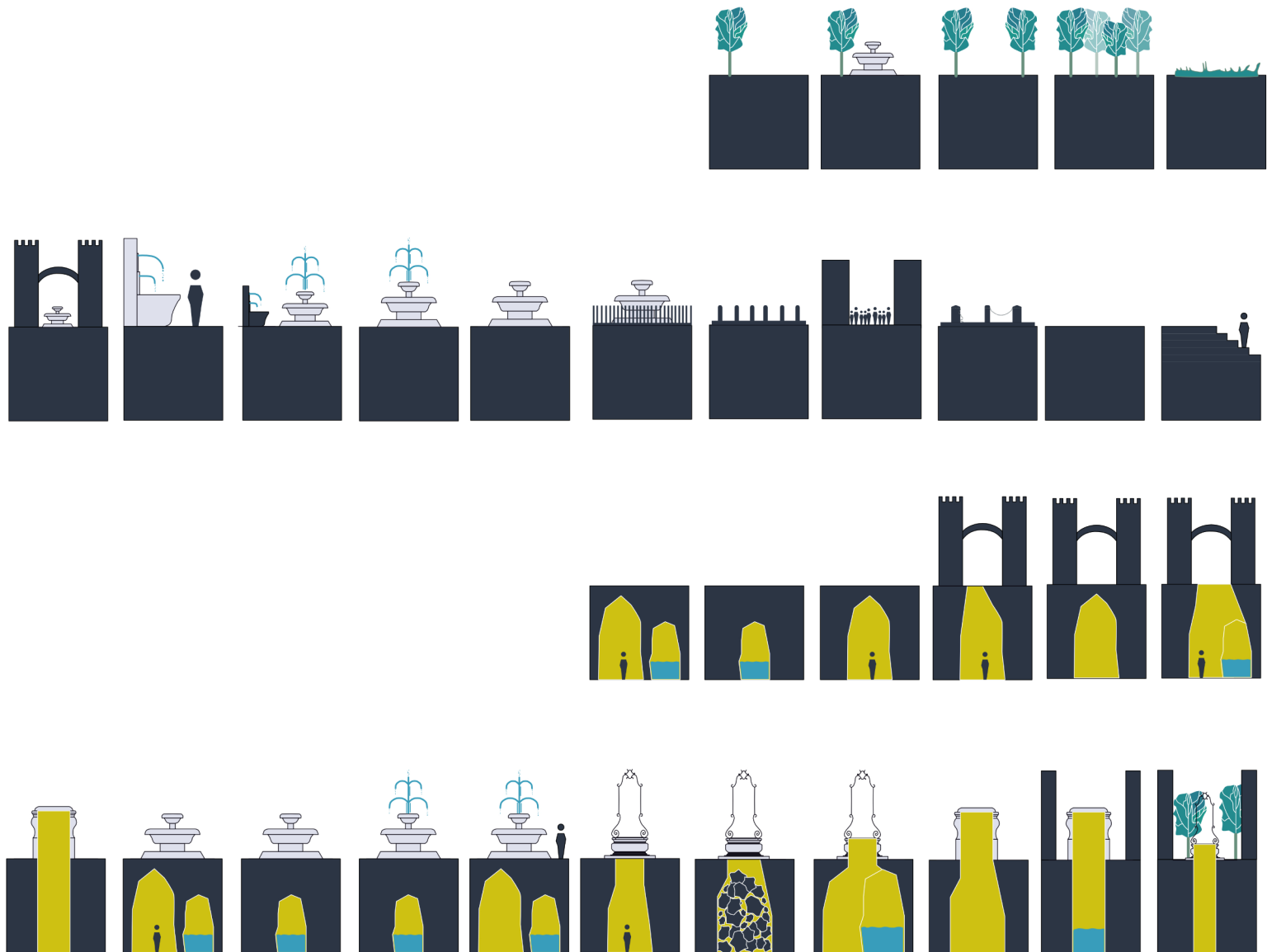
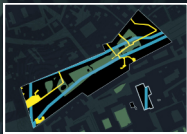
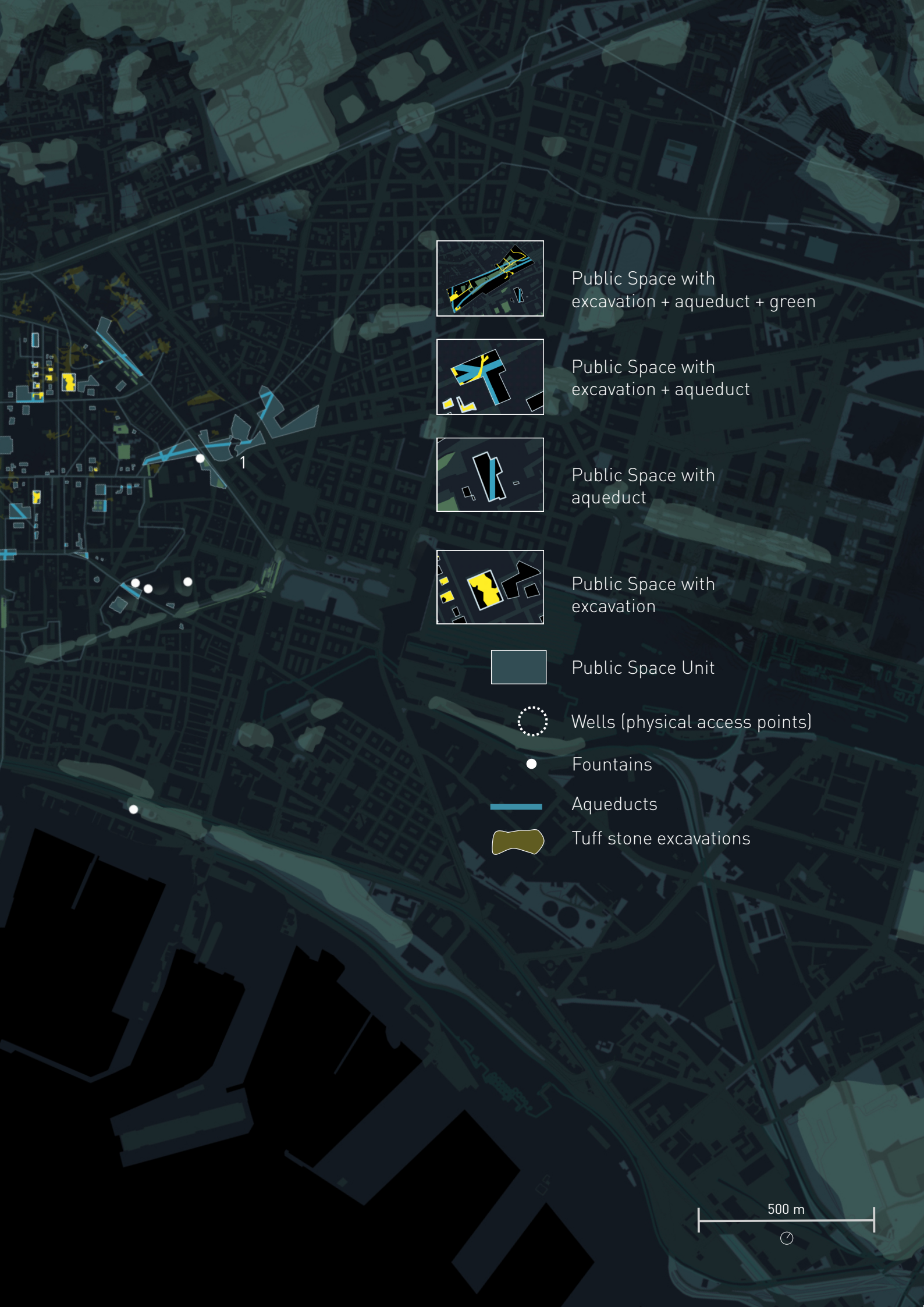


Fig. 52 Public Space Configurations across the city center
with or without a hidden relationship to the subterranean landscape



Fig. 53 Identifying Landscape Infrastructure Components

Map created by Regina Klinger, TU Delft using data provided by:
Google (2024), LAN/CoolCity, Geofabrik (2024), Manuel Orabona, Istat (2011), UNESCO, Comune di Napoli (1967)



Public Space with
excavation + aqueduct + green



Public Space with
excavation + aqueduct



Public Space with
aqueduct



Public Space with
excavation



Public Space Unit



Wells (physical access points)



Fountains



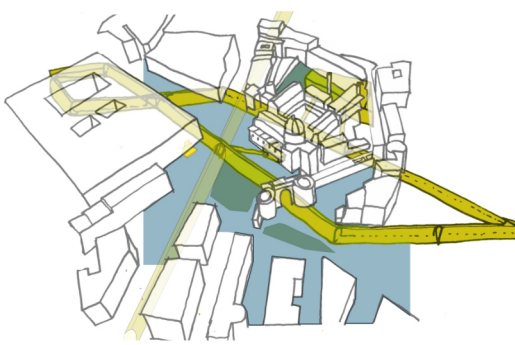
Aqueducts



Tuff stone excavations

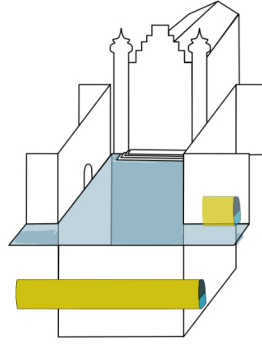


Current two-dimensional space typologies



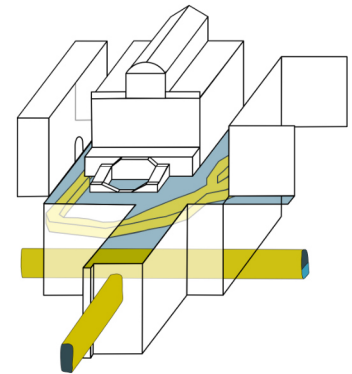
Public Space with green, hidden aqueducts and cisterns

Porta Capuana
Piazza Enrico de Nicola



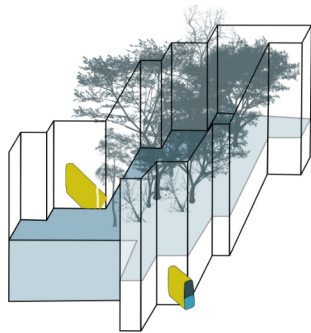
Public Space with gastronomy use

Piazza Gerolomini
Via dei Tribunali



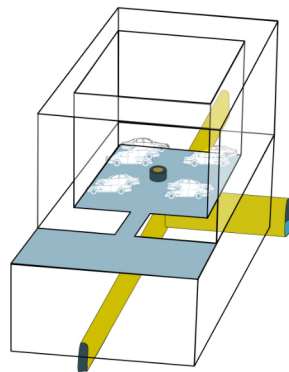
Public Space between entrance points to "Napoli Sotterranea"

Piazza San Gaetano
Via dei Tribunali



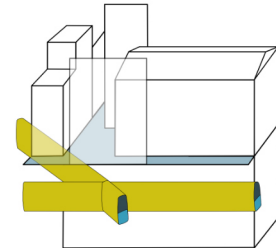
Private residential green courtyard

Private residential courtyard
Via Francesco de santis



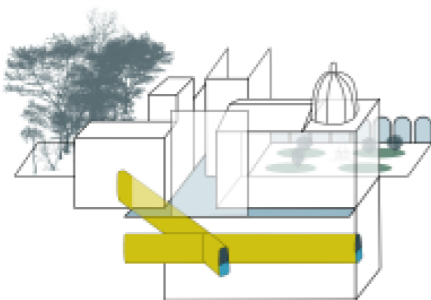
Collective parking lot with closed well in front of Basilica dello Spirito Santo

Dipartimento di Architettura
Via Toledo



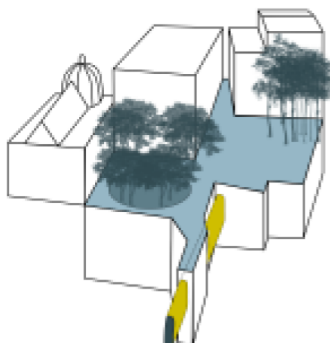
Public compact square

Largo Corpo di Napoli
Via Nilo



Public compact square with well and garden next to it

Santa Maria di Monteverginella
Via Giovanni Paladino



Public square with trees

Largo San Giovanni Maggiore
Via Candelora

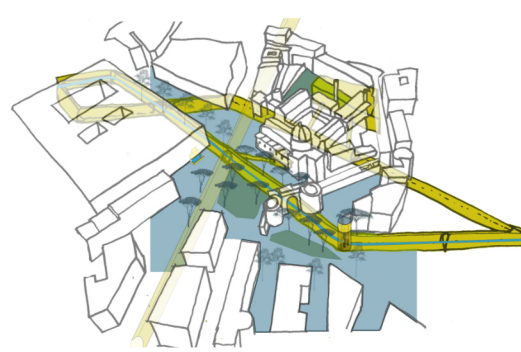


Private/Hidden cloister garden with well

Chiostro di San Francesco
Via Santa Maria la Nova

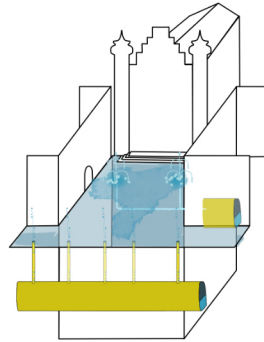
Fig. 54 Public spaces currently detached from the existing subterranean landscape system

Potential three-dimensional public space typologies



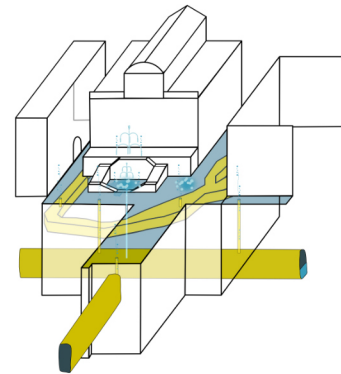
Public Space with green, walkable aqueducts and cisterns for water collection

Porta Capuana
Piazza Enrico de Nicola



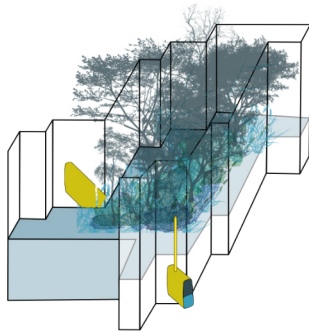
Public Space with cooling water elements and gastronomy use

Piazza Gerolomini
Via dei Tribunali



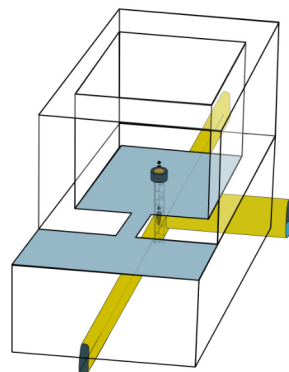
Public Space representing "Napoli Sotterranea" through air and water

Piazza San Gaetano
Via dei Tribunali



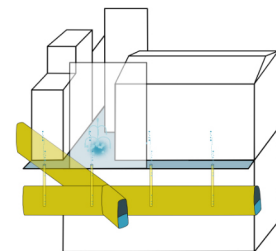
Private rewetted residential green courtyard with higher evapotranspiration

Private residential courtyard
Via Francesco de santis



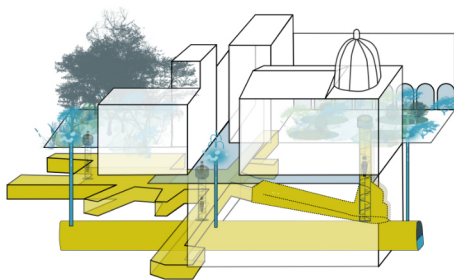
Collective space with opened well as access point in front of Basilica dello Spirito Santo

Dipartimento di Architettura
Via Toledo



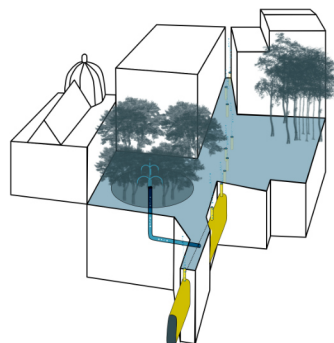
Public compact square with micro air- and water interventions

Largo Corpo di Napoli
Via Nilo



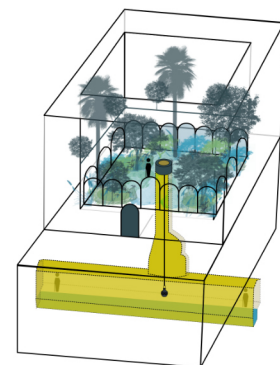
Public compact square connected to well and garden

Santa Maria di Monteverginella
Via Giovanni Paladino



Public square with irrigation and air pipes

Largo San Giovanni Maggiore
Via Candelora



Private/Hidden cloister garden with public connection to well

Chiostro di San Francesco
Via Santa Maria la Nova

Fig. 55 Future public spaces with a spatial relationship to the subterranean landscape system



4.8 Narratives

The current public spaces, the Neapolitan waters and the underground world are filled with narratives telling stories related to these elements.

Many of the Neapolitan inhabitants are spiritual and have a strong faith. Whether it is the faith in catholic values, superstition or the fascination about football and especially their faith into their beloved football player Maradona. Neapolitans treat their environment with passion and express their opinions openly, creating spaces expressing themselves. Because there is a lack of quality public space, people express themselves through setting up small altars and candles into the streets, but also many streets, corners and collective spaces have been decorated with posters and murals of Maradona, representing a vivid and passionate sense of belonging to the same team.

East Naples

Beyond football and saints, water itself carries narrative meaning in Naples. As Prof. Palestino (2024) noted, Naples is a city full of invisible infrastructures and overlapping layers that are rarely addressed through urban planning, leaving much of the subterranean world as a space of memory and myth rather than of coordinated development. Residents of East Naples, where the water feeding the city and aqueducts is coming from, especially in Ponticelli and Barra, still remember the times when the land was fertile and crossed by small rivulets and wells, long before industrialisation or urban expansion happened. Oral histories and interviews reveal that people strongly associate water with social life, memory and local identity. This is reflected in how residents remember fountains not only as



sources of drinking water, but as places for gathering, talking and exchanging, where “the social fabric was held together through shared rituals” (Palestino, 2024). Furthermore, Naples often fails to recognise the embedded memory within ordinary infrastructure. There are many water-related places in the eastern districts that are not remembered through maps, but through song. Older residents sing verses linked to wells, bridges and rivers now covered or forgotten. These songs, passed from generation to generation, form an oral cartography. They show how water becomes a medium for memory, belonging and loss, especially in neighbourhoods where public spaces have failed to deliver quality, but stories have kept the past alive. (Palestino, 2024, personal communication)

By thinking about which images to represent in the future design of the spaces that relate to the water system, it is important to understand what Neapolitans relate to when talking about their waters. A study about eastern Naples was conducted with interviews across different generations and neighborhoods to investigate lived experience and expectations related to water. Eastern Naples is the area where the water comes from that used to fill the Bolla aqueduct that entered at the eastern entrance gate at Porta Capuana. Respondents were asked to recall memories, express needs and select preferred spatial situations involving water. The outcome shows how water is remembered and desired in different ways, based on age and background. Elderly respondents tended to value everyday water features such as wells, basins and shaded areas for animals or washing, pointing to their role in social life and daily comfort. Younger participants were more drawn to playful images of fountain plazas or northern European riverfronts, often detached from the context of Naples. Despite this, common preferences emerged: shaded water spaces, green patios, and the idea of proximity to fresh water were selected across all groups as desirable. These findings were essential in defining which typologies hold not only spatial relevance but also symbolic and emotional meaning. (Palestino, 2022)

'O Monaciello

There are also stories attached to the underground world, revealing myths about the subterranean life within the excavations. The mythical presence of the little monk 'O Monaciello is said to have originated from the pozzari, the small and agile well workers who accessed Naples' homes through water shafts and wells. They often were from the same family possessing a house that is being connected to the water system, so the profession of an underground well worker was emotionally strongly embedded into the local context of family and home. The pozzieri's mysterious movements represented an image of a spirit who could either bring good or bad to the households being connected to the subsurface. According to the legend, if he wore a red cap, he brought luck. If he wore black, he might cause chaos. Even today, many Neapolitans speak of 'O Monaciello not just with irony, but with a sense of respect as he embodies the complex and mystically charged relationship between the people and their underground city (Hydria Virtual Museum, n.d.).

Another legend around 'O Monaciello is a story of love and tragedy. It is about Caterinella Frezza, a daughter from a wealthy family, and Stephen Mariconda from the working class. They were lovers from different social classes who met in a secret place in the underground of Naples which they reached through the wells and tunnels. Their affair, hidden from society, was made possible by the very infrastructure designed to serve water. The family of Caterinella was against this love and traced back the couple's secret meeting point and murdered him. After Mariconda's tragic death, their love story remained tied to the underground and is a reminder of how spaces of necessity can also become spaces of intimacy. (Hydria Virtual Museum, n.d.).

These narratives point out the former importance of water for the Neapolitans and that the past they remember is strongly attached to the waters that once brought life to the families and the city. The swampy landscape between the volcano Mount Vesuvius and the city of Naples is seen as the lost fertile, green-blue agricultural land with bridges, canals and fountains in the villages. It is important to understand these emotional images that endure until today to find the right image form in the design. Furthermore, it is crucial to understand the narratives and myths attached to the excavated spaces beneath the city as they give important hints of the (former) dynamics and use of these spaces. They demonstrate how well the subterranean world was connecting the whole city, meaning that stairs, walkable channels and vertical openings to the surface were a common part of the subterranean structure that interacted



Fig. 58 Piazza Municipio in the 1960 (author unknown)



Fig. 59 Piazza Municipio after the completion of the metro station in 2022 (Source: Fabiana Bianchi/Repubblica)

strongly and logistically with the surface. This knowledge can be helping in re-installing this very infrastructure and even enhance it to provide public space qualities.

4.9 Lost water places

Through a series of radical transformations, many water-related public spaces in Naples have disappeared or been altered beyond recognition. These changes range from the sealing and construction over of historic wells to the removal or relocation of monumental fountains. This process intensified during the late nineteenth century, particularly during the period of Risanamento (sanitation), which followed the cholera epidemic of 1884. In response to the public health crisis, large parts of the historic center were reconstructed, and ancient water infrastructures, including aqueducts and cisterns, were disconnected or buried due to their association with disease (Gentilcore, 2019; Hydria Virtual Museum, n.d.).

The physical erasure of these elements has contributed to the loss of a shared water culture in Naples. Water, once visible and accessible in daily urban life, was gradually withdrawn from public space. This reduced not only its physical presence but also its symbolic value. In turn, the water features once present in Piazza Municipio (fig. 58) were dismantled in 2015 to make way for the construction of the new metro station (fig. 59). This included the removal of circular and rectangular basins that had defined the plaza since the 1950s. Earlier still, historic fountains such as the Specchi fountain near the Maschio Angioino were demolished during the sanitation campaigns of the nineteenth century. These removals reflect how water features have often been sacrificed in the name of infrastructure and modernization (Piazza Municipio, 2024).

The consequences of this transformation extend beyond aesthetics. The removal of accessible water spaces has weakened the historical relationship between inhabitants and water. This detachment is particularly visible in lower-income districts, where the closure of wells and the sealing of courtyards reduced local resilience during heat events and water shortages. As Esposito (2023) argues, the loss of local infrastructures often goes hand in hand with the decline of community-oriented spatial practices. The absence of water in public space thus not only reflects a technical shift but also a cultural and social loss.

Consequently, tracing back these water elements as an important social and aesthetic element helps to inform the design approach in the later stages and also relate them to past realities of the city of Naples.



Fig. 60 Piazza del Plebiscito with its fountain “fontana del Serino” around 1900

(Source: Napoliduiunavolta, napolicapitaleidunregno)



Fig. 61 Piazza del Plebiscito in 2024

(Source: Google Street View)



5

International Cases

To understand the situation of Naples better and dive into the possibilities, several UNESCO heritage sites in similar topographic, climatic conditions and water backgrounds were analyzed. They all have a water story to tell, that is why they were analyzed on whether the water stories are narrated in the public spaces.

Furthermore, design precedents were researched to gather insights about how other cities with similar challenges deal with their underground systems. But also the look into international cases holds the possibility for inspiration, to create design opportunities above and below ground that accentuate the presence of the landscape infrastructure based on "Vertical Blue".

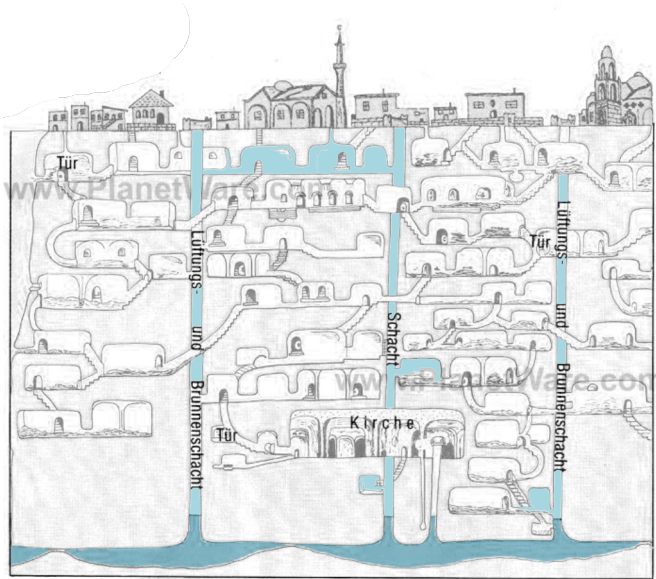


Fig. 62 Underground living within Derinkuyu (Source: PlanetWare)



Fig. 63 Yerebatan Sarnıcı or Basilica Cistern around the Hagia Sophia Mosque (Source: istanbultarihi)



Fig. 64 Yerebatan Sarnıcı or Basilica Cistern in 2024 (Source: Diego Delso, delso.photo, License CC BY-SA)



Fig. 65 Intervention point along the Hadrian Aqueduct in Chalandri (Source: Cultural HIDRANT FB page)



Fig. 66 Irrigation point along the Hadrian Aqueduct in Chalandri (Source: Cultural HIDRANT FB page)

5.1 Subterranean City of Derinkuyu

Derinkuyu, an UNESCO site located in the Cappadocia region of central Anatolia (TR), is one of the largest subterranean cities ever constructed. Similar to Naples underground structures, it was carved entirely into soft volcanic tuff stone. The underground system spans up to 18 floors and reaches depths of 85 meters. With a capacity to house up to 20,000 inhabitants, this historical underground network offers inspiration on how to use the subterranean space not only as functional but also socially connecting and climate-responsive infrastructure.

Of specific relevance to this thesis is the porous tuff stone that supported a cool and stable microclimate, and ventilation shafts distributed air across all levels (fig. 62). This combination turned the underground world into a liveable and climatically stable environment. The careful integration of water systems according to the landscape's features and accessibility created an underground structure that supported both everyday life and shelter. Derinkuyu also formed part of a larger network, connected to the nearby city of Kaymakli through a tunnel system of approximately nine kilometers. This regional scale connection that goes beyond the singular excavation, relates to the aqueduct network in Naples.

The case of Derinkuyu illustrates how water, air and space can be interwoven into a multi-purpose system that supports resilience, continuity and climate adaptation underground.

5.2 Istanbul

The city of Istanbul (TR) relied on an extensive and highly sophisticated water system to supply its densely built and strategically important capital. This infrastructure consisted of underground cisterns and channels. Of particular relevance is the Basilica Cistern (fig. 63; 64) within the UNESCO heritage zone, one of the largest subterranean water reservoirs, constructed in the 6th century. Its design not only stored water but also distributed it to the imperial palace and key public buildings. Especially artwork shows the early understanding of these cisterns as landscape, visible through painting vegetation in the underground water space of the cistern (grape, add picture of sailor in the cistern). These cisterns were carefully engineered voids, supported by rows of columns that created monumental subterranean interiors. Their construction aimed to ensure climate stability and water security within a vulnerable political and geographical setting. The Basilica Cistern, located close to the Hagia Sophia, represents a prime example of how underground systems contributed to urban resilience by making water accessible in times of siege or drought. Today it is inactive, serving as a tourist attraction, only running a few centimetres of water and together with statues and light installations it stages the former atmosphere of this underground space.

However, above the ground the story of this extensive water complex is not specifically readable. Next to the extensive paved area above the cistern, a park and a bigger fountain mark a quality public space, however more as a decorative, superficial feature instead of relating to the subterranean water landscape. In the case of Istanbul it becomes clear that again, an important and original structure of the cities history is only exposed to commercial and touristic use, instead of serving as an infrastructure profiting the local social dynamics, the inhabitants, the neighbourhoods, climate and ecology.

5.3 Athens

In Chalandri, a suburb of Athens (GR), the Hadrianic Aqueduct has recently been cleaned and reactivated (figs. 65; 66). Originally built in the second century AD, the aqueduct collected water from Mount Parnitha and brought it into the city using gravity and shows therefore a similar set up as Naples, where the water flows from Mount Vesuvius via the Bolla aqueduct towards the city center. After centuries of neglect, modern initiatives have aimed to restore and repurpose this ancient Greek infrastructure. Today, the Cultural H.ID.RA.N.T. initiative focuses on restoring this historic water infrastructure to irrigate public green spaces. The project also



Fig. 67 De Ruien in Antwerp as a walkable structure - Takeaway for Naples: Water and walkable subterranean space can go together (Source: Marieke K. via Tripadvisor)

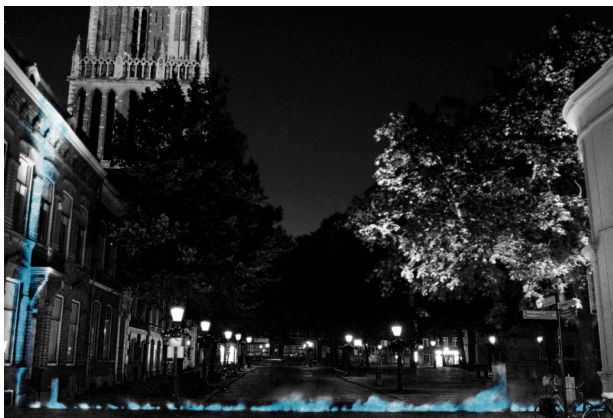


Fig. 68 Domplein in Utrecht - light installation along the former line of the fortification (Source: OKRA landschapsarchitecten)



Fig. 69 Domplein in Utrecht - engraved narratives in the paving (Source: OKRA landschapsarchitecten)

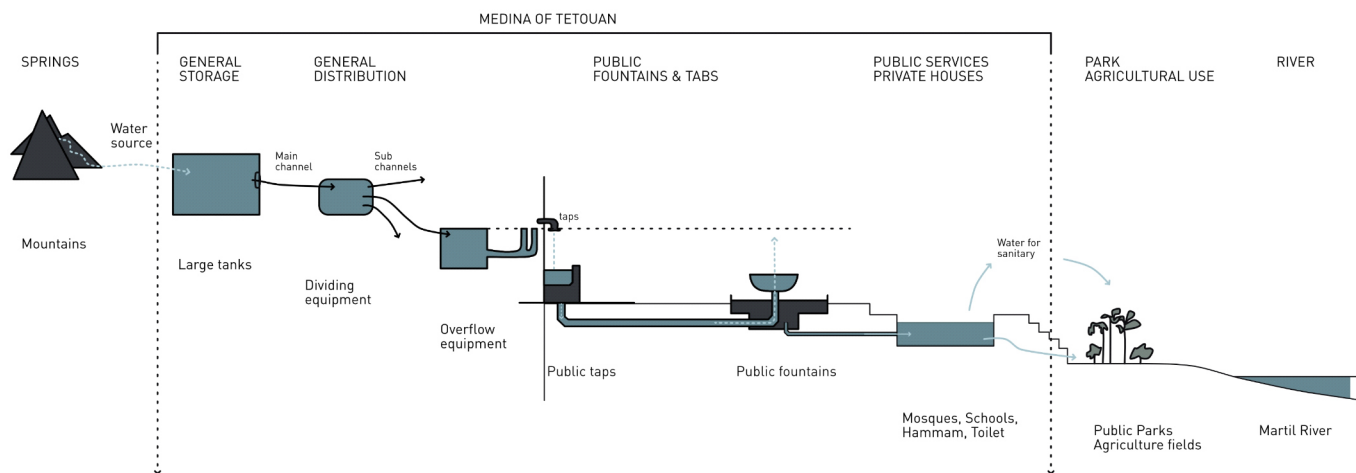


Fig. 70 Skundo System in Tetouan - A gravity and overflow based water distribution system (Drawing by author based on handdrawing by C. Chang)

involves local communities to enhance social awareness and ownership. By reusing non-potable water, it reduces reliance on energy-intensive potable sources and contributes to sustainable urban cooling. This restoration combines cultural heritage conservation with contemporary environmental needs, demonstrating how historical infrastructures can still have practical value today (Cheshmehzangi et al., 2025; Greek News Agenda, 2023).

5.4 Antwerp De Ruien

De Ruien in Antwerp (B) provides a relevant example of how historical underground water channels (fig. 67) can be transformed into accessible public spaces. Initially open canals for transport and drainage, these water channels were gradually covered and integrated into the city's sewage system. Today, De Ruien functions both as an active drainage infrastructure and as a publicly accessible pathway for visitors. This combination of functional water management and public use has revitalised an overlooked part of the city, turning infrastructure into a space for exploration and environmental education. Inspired by this dual-function approach, the Naples proposal similarly envisions the ancient aqueduct channels as spaces where water continues to flow while visitors experience the city's subterranean heritage through walkable paths, creating both environmental awareness and a new public experience. (De Ruien, n.d.)

5.5 Utrecht

The Damplein project in Utrecht (NL), designed by OKRA Landschapsarchitecten, shows an example of how subtle surface interventions can reveal and celebrate buried historical infrastructure in public spaces. The square is situated above the remnants of a Roman castellum, and its design employs a linear arrangement of cor-ten steel elements (fig. 69) embedded in the pavement to trace the former outline of the Roman walls. This minimalistic approach is enhanced by dynamic lighting and mist effects (fig. 68), which activate the space during specific times and events, making the hidden history perceptible and engaging for the public again. (OKRA Landschapsarchitecten, 2010)

This strategy of marking and animating subterranean heritage informs the design approach for Naples' aqueduct channels. By implementing surface-level cues and sensory experiences, the proposal aims to reconnect citizens with the city's hidden water infrastructure, creating a deeper understanding and appreciation of its historical significance.

5.6 Tetouan

The city of Tetouan (MAR) is as well an UNESCO heritage site and helps to understand the relationship between subterranean water infrastructure and surface public life activation through water in compact and historic urban contexts like the Medina. Located between the Dersa mountains and river landscape, Tetouan makes use of its elevated geography that allows for a gravity-fed water system known as the skundo system (fig. 70). This ancient system collects clean mountain water and distributes it underground through an overflow system of clay pipes, feeding essential public structures such as mosques, hammams, fountains, madrasas, and residential courtyards throughout the medina.

The skundo system enables water to enter the daily life of the city. The subterranean infrastructure reaches the public space in the form of fountains, religious purification spaces, and even decorative or functional water features within residential streets and public squares. Gravity, water pressure, and natural materials such as clay play a central role in distributing and purifying the water.

Furthermore, public awareness and interaction with the skundo system is maintained through ritual use. The integration of water into places of prayer, bathing, and gathering ensures that

the subterranean water landscape remains part of the experience on surface-level. This continuous dialogue between surface and subterranean systems is a source for resilience, climatic comfort and social interaction.

Tetouan is therefore an example city where subterranean water is not isolated from daily life but serves as a backbone for a socially inclusive public space. The integration of water systems with cultural practices and private garden irrigation provides a rich reference for Naples. (Dijkstra et al., 2024)

5.7 Venice

Venice's (IT) relationship with water is evident in its reliance on cisterns for freshwater storage within the salty lagoon surrounding it. The inhabitants had to be clever about how rainwater was collected from rooftops and courtyards. On the spot, where the water arrived, they infiltrated the water into the ground, let it run through purifying sand layers and clay walls and stored it in underground cisterns located beneath public squares and private courtyards. Above the cisterns they introduced wells (or pozzi) (fig. 71), similar to Naples wells, that reached down into the subterranean cisterns to tap the water. The water carrying was therefore a social practice that was institutionalized in public spaces as a social connector. This system not only addressed the scarcity of freshwater and a necessary solution to it but also influenced the city's architectural and urban development, integrating water management into the public spaces of Venetian life (University of Wisconsin-Madison, n.d.).

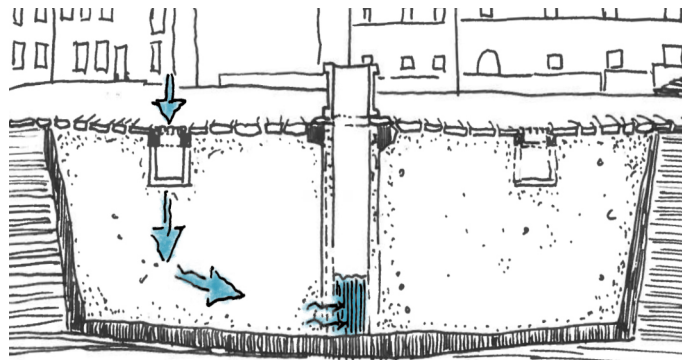
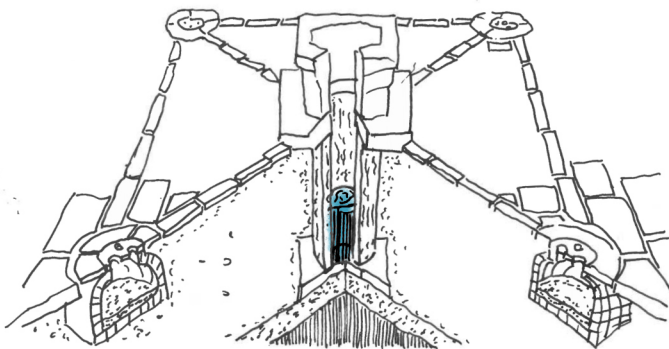


Fig. 71 On-the-spot freshwater well for water catchment, filtrates rainwater through sand and claywalls and stores it in an isolated well within the salt lagoon of Venice

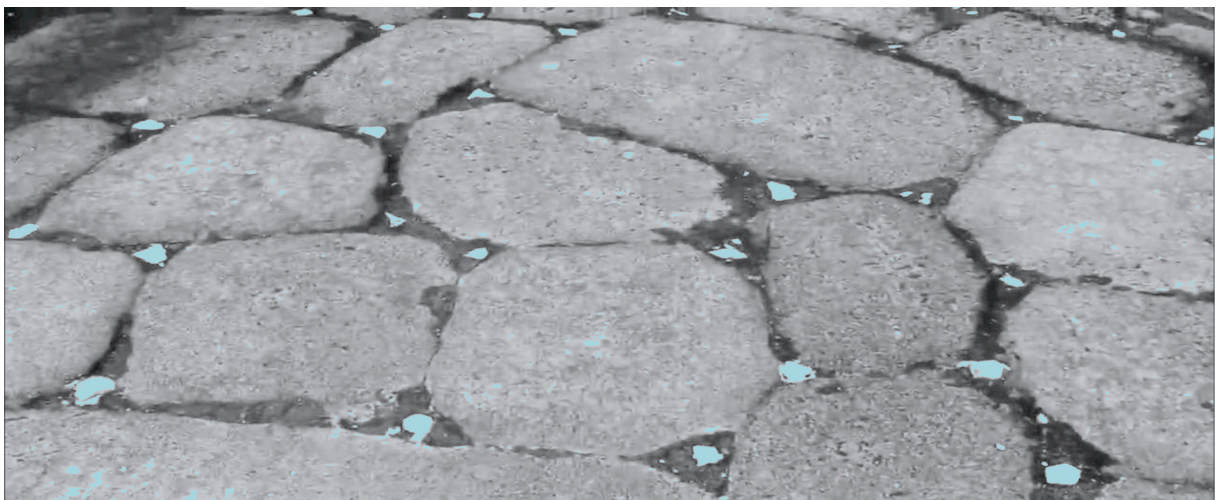


Fig. 72 High-Visibility stones in Pompeii's streets that light up during the night when moonlight falls on them (Source: The Archaeologist)

5.8 Pompeii

The ancient streets of Pompeii (IT) demonstrate a subtle yet effective way of integrating practical infrastructure into everyday life, but especially at night. Embedded among the darker basalt paving stones, small white marble stones (fig. 72), also called moon stones, provided guidance at night by reflecting moonlight and enhancing visibility (The Archaeologist, 2024). This low-tech, sustainable solution highlights how historical design approaches can inform contemporary urban strategies. Reflective stones exemplify a sensitive response to local conditions and resources, an approach that resonates with the idea of OKRA's Domplein paving design and puts up a chance for Naples' story to be told on the surface. Like Pompeii's reflective paving, subtle design interventions can reveal the presence of hidden systems below and improve urban life and orientation without extensive use of infrastructure or electricity.

5.9 Synthesis

The case studies presented in this chapter highlight different ways in which historical water systems can be reintroduced into contemporary urban life. Although they vary in climate and context, each example offers specific lessons for Naples. In Antwerp, the reuse of De Ruijn shows how underground channels can remain in service while becoming accessible public walkways (De Ruijn, n.d.). Athens demonstrates how an aqueduct can be cleaned, reopened and used for irrigation through gradual steps and with community involvement (Cheshmehzangi et al., 2025; Greek News Agenda, 2023). Utrecht's Domplein project proves that small, precise surface interventions can reveal and activate deeply buried layers of meaning (OKRA Landschapsarchitecten, 2010). The streets of Pompeii, where reflective stones guided movement at night, suggest how infrastructure can also shape perception and orientation (The Archaeologist, 2024).

From these examples it becomes clear that in Naples, the underground water system should be made spatially accessible and visible and especially gain meaning when tied to daily use or collective memory. Additionally, this can contribute to cooler, more resilient environments in Naples' public spaces when used as a climatic resource. For Naples, this means engaging with the aqueduct system as an active spatial structure. Its vertical connections to the surface offer the chance to create a continuous series of public places, shaped by water, humidity and air. These findings form the transition to the next chapter, which gathers the conclusions of the research and prepares the ground for the design proposal.



Conclusion of the Analysis

Following the layered exploration of Naples through regional mapping, architectural surveys, human-scale observations and international case studies, the previous chapters have revealed both the vulnerabilities and potentials of the city's public spaces in relation to its subterranean water system. The examples from other heritage cities have shown that compact urban contexts with complex histories can successfully be inhabited or integrate underground infrastructures into the public domain when these are addressed as spatial, cultural and ecological assets. Despite its richness in layered infrastructures, Naples remains spatially fragmented and challenged on several levels. The subterranean landscape holds significant potential for creating new spatial and climatic conditions on the surface and yet it remains mostly unacknowledged in contemporary planning and design. The following sections now gather the main challenges and opportunities that have emerged, forming the groundwork for the development of a strategic landscape infrastructure in Chapter IV.



Fig. 73 High pressure on the city center's streets

6.1 Challenges

Naples's challenges stretch across many different parts of its urban context. By addressing different challenges and connecting the dots, the creation of a landscape infrastructure mitigating the current problems can be informed. From socially unjust living and public space conditions to being exposed to straining climatical conditions while being part of an aging population is only one of the many realities people in Naples have to deal with. In the following, the main challenges of the city are being outlined.

Social challenges in Naples' city center

The population in Naples' city center relies on the mass-tourism happening there (fig. 73). Inhabitants are making more money through turning their long-term rental properties into touristic short-term ones (fig. 74). The mass tourism drives displacement of the inhabitants to their own city. Meaning it nourishes "a process of un-homing that severs the links between residents and the communities to which they belong, [...] including experiential, financial, social, familial and ecological." (Elliott-Cooper, Hubbard, & Lees, 2019) Adding to it, in the city center of Naples, up to 36,8 % are unemployed and up to 25,2 % are not in education, employment or training (fig. 75), making it one of the most socially challenged areas in Naples (fig. 78) being additionally detached from their urban identity (Esposito, 2023).

Many of the locals who still reside in Naples' historic center live in precarious conditions in ground-floor units known as *vasci*, where the entrance door is mostly the only opening to the outside. These spaces are officially classified as non-residential and are not legally inhabitable under current building regulations, due to insufficient air circulation and lack of natural light (Esposito, 2023, p. 3). Consequently, public spaces that are climate-adaptive and feature socio-ecological value are essential for everyday life.

Furthermore, the population of Naples is growing older, and life expectancy is increasing, leading to a vulnerable age group residing longer in the city of Naples in the future that has to deal with the occurring challenges happening there (Tuttitalia.it, 2024).

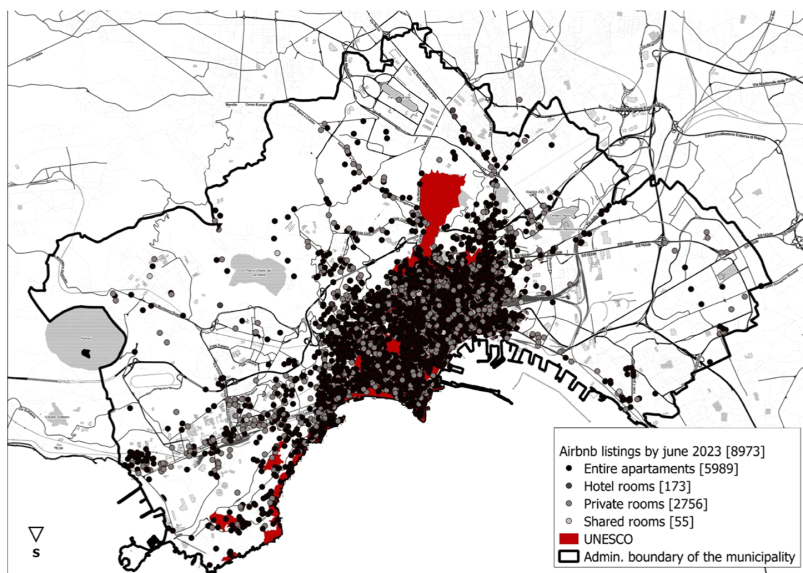


Fig. 74 Distribution of Airbnb listings in Naples (2021) in overlay with the UNESCO heritage site [Source: Esposito, 2023; Airbnb]

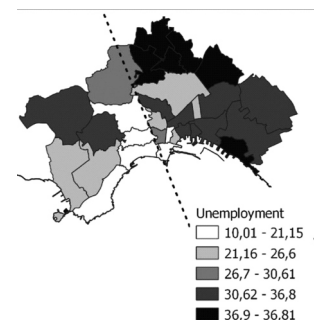
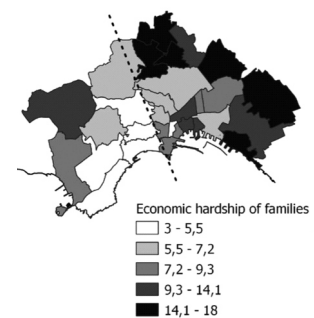


Fig. 75 Social polarisation and its spatial distribution [Source: Esposito, 2023]
*NEET: Not in Education, Employment or Training.
Data Source: Istat (2011)

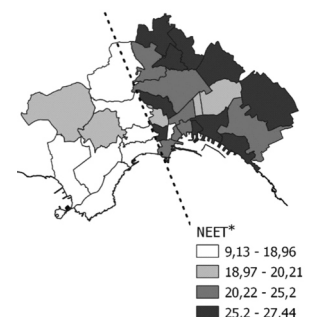




Fig. 76 *Altarinu* in a narrow alley near Porta Capuana. While vertical walls dominate and open space is scarce, everyday spiritual and ecological gestures create micro-conditions of care and identity.

Ecological Challenges

In the city center of Naples, we find a fragmented system of green spaces (fig. 78). By walking the streets there is hardly any continuous public green to find besides some singular trees, tree groups and some short alleyways. Because of the typical architecture of the buildings, most of the green is hidden within private to semi-private courtyards that partly request payment for entrance. This makes it difficult to access these structures for public use.

Furthermore, the ecology of the porous and airy tuff stone is not yet integrated into sustainable urban development. The material that the city is built from holds undiscovered qualities that could be used for ecological improvement.

Climatical challenges

Additionally, the climate gets hotter, meaning the stony context of the city center turns into a dangerous urban heat island (fig. 78) affecting health, ecological security and overall well-being during the hottest days (fig. 77). The research by Cafaro et al. (2024) illustrates that some areas of Naples, particularly in the city center, show extremely high building densities, low soil permeability, and an almost complete absence of vegetation. These combined conditions not only intensify the urban heat island effect but can be interpreted as early indicators of an urban desertification process. This indicates a pressing need to mitigate such phenomena through green and blue infrastructure integration within the historic core.

The climate not only gets hotter, but the people are also becoming older. So there lies a certain vulnerability not only in the socio-ecological challenges but also in the fact that being socially challenged and tendentially becoming older means that the climate will affect the inhabitants more when it comes to liveability and personal wellbeing.

Consequently, social vulnerability is strongly connected to climate vulnerability.

Spatial challenges

Furthermore, the urban layout is characterized by narrow medieval streets and highly sealed public spaces. Almost all the streets are open to motor vehicles, which consequently leads to heavy traffic and over crowdedness (fig. 78) due to mass tourism. In addition to that, the chaotic streets of the city center are subject to micro-scale commercialism filling up the last bits of empty space within the city and are the main program for most of the public spaces.

In addition to the physical and functional fragmentation of the public space structures in Naples, there is a broader cultural issue concerning the collective perception of these spaces. As Aveta (2012) notes, many green structures have gradually faded from public consciousness and are no longer existing or recognized as essential elements of urban life. What is generally referred to as public space often lacks the qualities and accessibility that define it as such. In many cases, there is simply no real public space in the formal sense, but rather a mixture of informal, underused and poorly maintained areas where oftentimes garbage accumulates. Their historical, social and ecological significance is overlooked, and their informal character has led to decay and a general absence of care. The disconnection between residents and their surroundings has contributed to a widespread underestimation of the role that public space can play in shaping their everyday lives. As a result, many of these areas fail to provide ecological, social or climatic value and instead appear as degraded fragments of a once vibrant and interconnected city.



Fig. 77 Naples exposed to sun - Piazza Vincenzo Calenda, Forcella



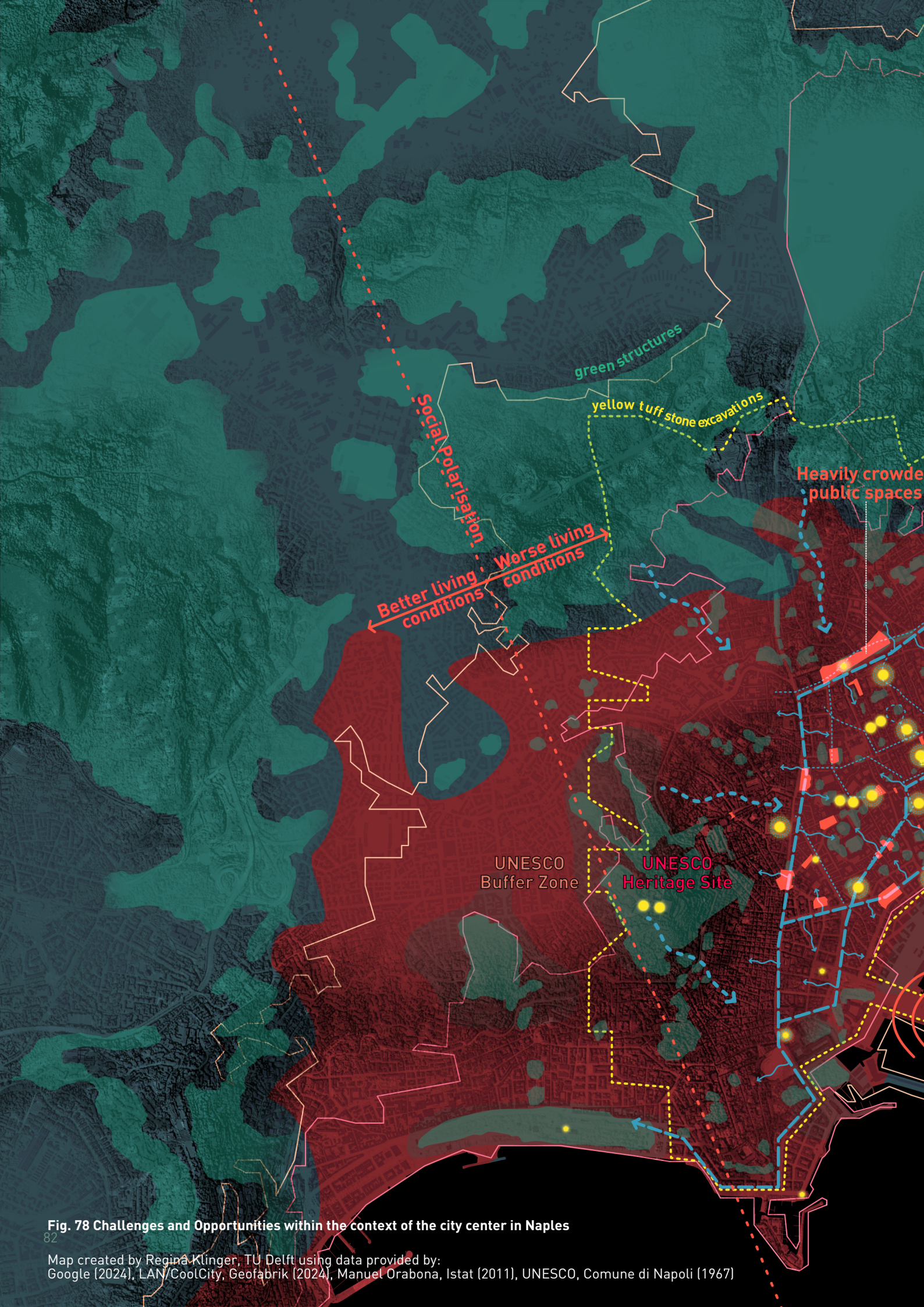
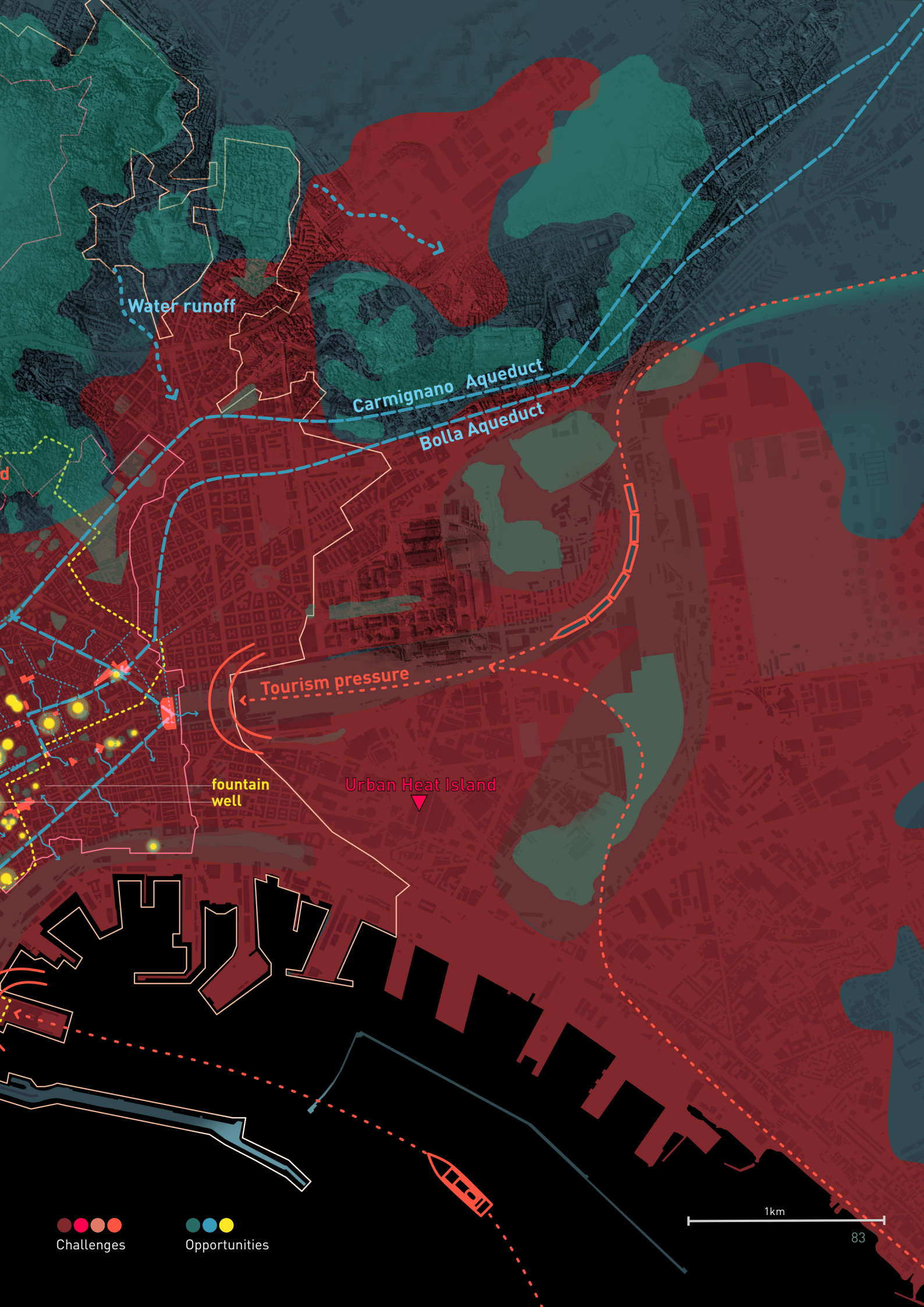


Fig. 78 Challenges and Opportunities within the context of the city center in Naples



6.2 Opportunities

What makes this subterranean infrastructure of caves, cisterns and channels so interesting is on the one hand the human scale of it. Every channel and tunnel was handcrafted by humans themselves, so many of these subterranean spaces fully fit humans to walk through. On the other hand, this subterranean world is connected to the surface through wells that used to be part of every bigger built unit. In fact, there used to be thousands of wells across the city through which you could theoretically enter at one side of the city and exit through another well on the other side of the city. Through WW II, many of these channels however got clogged when material of collapsed buildings and trash were thrown into the system (Hydria Virtual Museum, n.d). The sensorial and spatial elements of the cool underground air, water of around 14°C (Valentino, 2024) and a space continuum of caves from one part of the city to the other create conditions alongside the lines of the aqueducts that add a valuable spatial layer to the city that could become potential public space in the future.

This underground world responds directly to the challenges (fig. 78) addressed throughout the thesis. It offers spatial resources in a context where open space is scarce. New interventions at the surface often face limits because of density, historical value or infrastructure. But below the surface, there is volume. These spaces can become a hidden extension of public space. The cool and moist environment can offer thermal relief to exposed areas. Reopened wells can serve as vertical elements to bring fresh air, access points and symbolic value to streets, courtyards and alleys.

Socially, the structure of these spaces allows for quiet, shaded places of rest, outside the flow of traffic and tourism. Especially in districts with limited access to green areas or climate shelters, even small vertical connections can offer meaningful change. A well that is reopened, a fountain above a cistern, or a public corner cooled by groundwater and air can become places of care. The presence of water, once a shared element of daily life, can return as a spatial connector that links the past to a more inclusive future.

The system also supports spatial continuity across the fragmented structure of the historic city. It forms a network that crosses built blocks, closed courtyards and disconnected streets. This continuity can support new forms of access and shared use, even where the surface is divided. While surface transformations often reinforce existing patterns of access, the re-use of subterranean structures may bring change to areas that were left behind. These ideas are grounded in what already exists. They propose to work with the city's own material and spatial history and the underground can become part of the urban landscape.

The following chapter brings together the analytical results that helped to reach this understanding. It marks the moment in the thesis where observation turns into synthesis, and where the design direction becomes clear.

6.3 Summary of the Analysis

The analysis of Naples across regional, human and international scales has revealed the deep yet fragile relationship between water, public spaces, hidden green spaces and the built environment. The historic center today faces pressing social, ecological, climatical, and spatial challenges that leave it vulnerable to processes of degradation and disconnection. Public spaces are fragmented, often over-commercialized, and unable to provide climatic comfort or social cohesion. The absence of structured green and blue infrastructure, combined with the ongoing desertification processes and mass-tourism driven displacement, further reduces the liveability of the city center.

At the same time, the research has shown that a valuable yet underutilized infrastructure still exists beneath the surface: the system of aqueducts, wells, cisterns, and tuff stone excavations. These structures were historically connected to the everyday lives of Neapolitans, shaping public spaces, rituals, sense of belonging and social interaction.

However, the current disconnection from the surface world makes these invisible and unused for the contemporary needs of the city.

Through mapping, spatial analysis, site observations, and precedent studies, it became clear that reactivating the subterranean water system as a landscape infrastructure can provide multiple layers of socio-ecological value. It can create a climate-adaptive network, offer new forms of accessible public spaces, and reconnect the citizens of Naples with their lost water heritage. Furthermore, the case studies show that subtle but strategic interventions in water infrastructures can improve urban life in Naples.

The conclusion of the analysis therefore underlines the necessity of a landscape-based, multi-level, and water-oriented approach. It emphasizes that future development must no longer focus only on the architectural surfaces or micro-green structures of Naples, but embrace a three-dimensional understanding of space that includes the (still) invisible yet powerful layers beneath the city.

Naples' public space structures are hardly buffering the named challenges in any spatial form. A landscape-based approach represents therefore important approaches to more resilient and valuable public space structures as it takes the landscape as steady and reliable base. However, to be able to work with valuable landscape resources in the context of Naples, the understanding of "landscape" as such must shift from the typical green-city image we oftentimes have in mind, to a more diverse understanding of what is (left of) landscape within this very specific context. This means, the subterranean landscapes, the water infrastructure and micro-green spaces can all be understood as landscape features, some highly artificial elements based on topography, others still historic green from centuries ago. These features form a landscape between many levels and turn into a landscape infrastructure as soon as urban development is happening based on it. This happens when this infrastructure based on landscape creates certain conditions along its structure, for example social and ecological value.

It therefore is crucial to unbind the green stereotype of future cities from the context of Naples's city center. With the climate changing and desertification processes approaching in the region of Naples, we first have to think about the blue, before we can integrate any green at all: cool water, cool air, humidity and evapotranspiration.

It is now about creating a design as part of the research, that is redefining public space on multi-level, detaching it from chaos and commercial use and give back its identity and purpose: to bring justice to the inhabitants by giving them back a non-commercial, usable and resilient public space that establishes their identity again, brings back neighborhoods by fostering social cohesion, contributes to the increase in ecological value and creates better living conditions for all.

Building on these findings, the following Chapter IV introduces the overall design strategy and principles. It translates the analysis into layered design approaches that integrate the subterranean and surface worlds into one climate-adaptive, socio-ecologically inclusive public space system embedded into the landscape infrastructure.

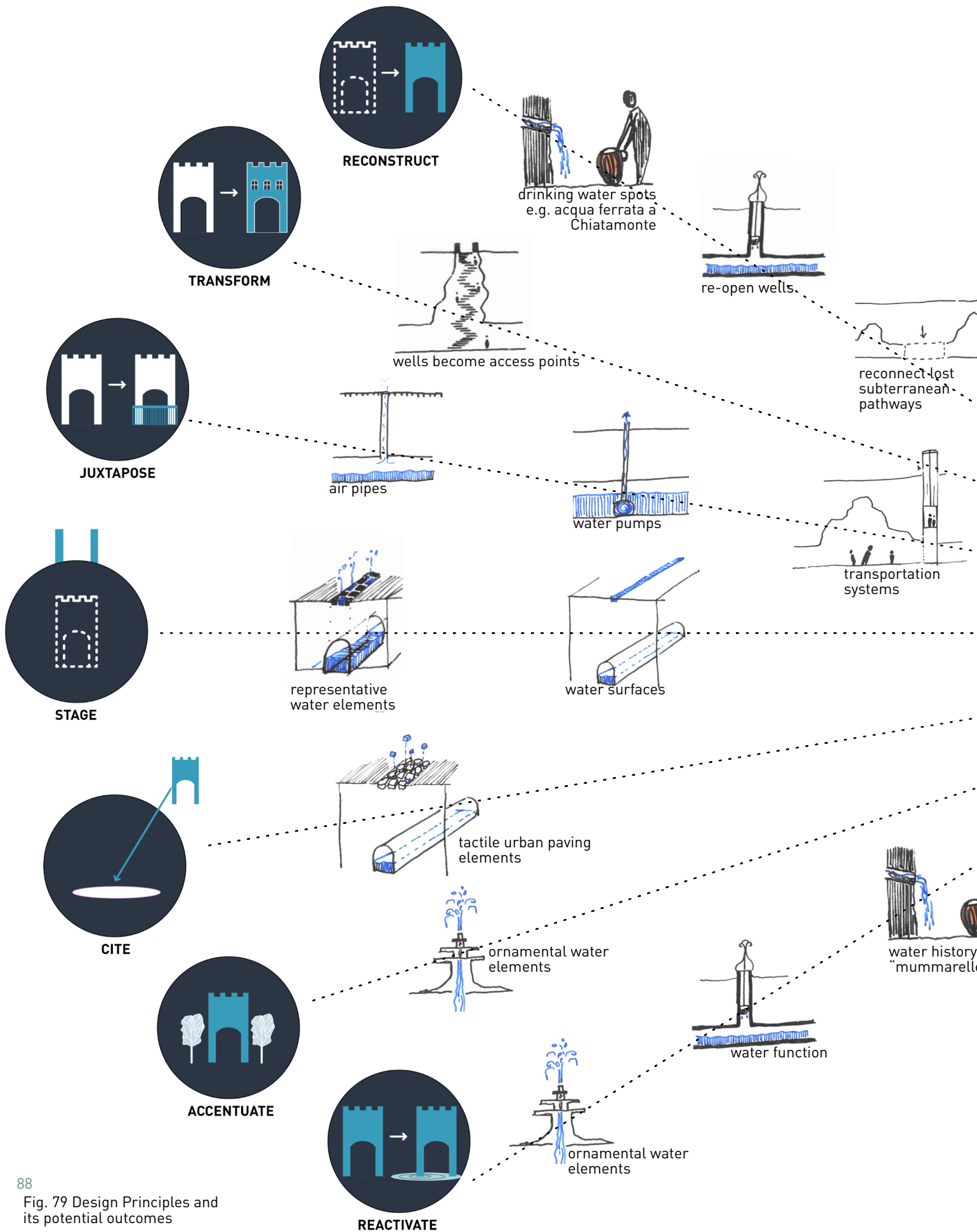
CHAPTER IV

DESIGN STRATEGY AND PRINCIPLES



Design Strategy

The implementation of the strategy follows a phased sequence, beginning with accessible interventions and gradually moving toward more structural transformation. The first step is to activate the water that is already present. At Porta Capuana, cisterns are reported to still hold water, and nearby aqueduct segments may also remain functional. The initial intervention involves installing pumps to bring water to the surface, which reintroduces water as a sensory and public element that allow people to see and touch it. In the second step, conditions for green infrastructure are created around these water points, to make the use of water possible also for irrigation, allowing shadowing vegetation to establish. The third step connects the water system to existing architectural elements such as wells, cisterns and fountains. These structures reach into private and collective spaces, enabling the soil to become wetter and microclimates to improve. The final step involves deeper excavation work in order to boost the cooling power. Dry aqueduct segments and voids can be reopened and made walkable, forming a continuous subterranean path where air- and waterflow improves. Once this system functions, a network of new openings and shafts can be introduced to allow cool air to flow up vertically into the heat of the city, additionally bringing light, sound and sense of belonging to both surface and subsurface.



7.1 Design Principles - Designing with Archaeology

The strategy of this design is being set up in layers, each touching on archaeology-sensitive design principles, as it is important to understand the relationship between the layers in order to find out through which designed form they will be connected to each other while respecting the UNESCO heritage.

To begin with, the archaeology-sensitive design pays respect to the diverse time layers in the subsoil, that are, in the case of Naples, represented by the layering of excavations, ancient water infrastructure as well as the surface-level city.

Integrating the layeredness and history attached to each layer requires more than the protection of heritage. The current challenges in the city of Naples require design strategies that recognize, reinterpret, and spatially activate the presence of (water) history in the form of water, cool air and the voids inheriting both, in the urban landscape. The public spaces in Naples' city center are layered with remains from epochs between ancient, medieval, Renaissance and gothic times, including aqueducts, cisterns, tuff stone voids, and ground-level ruins. To design respectfully and innovatively within this setting, this thesis adopts a set of six design principles formulated in the Dutch planning context by Adviesbureau Cuijpers (Marrewijk & Haytsma, 2004) and will be complemented by one more (fig. 79).

These principles are:

- 1. Reconstructing** lost or partially lost structures, e.g. functional wells, fountains, or former links between the different excavation spaces,
- 2. Transforming** a historical element into a new function or form that follows its historical logic, e.g. a cooling route that follows a buried aqueduct,
- 3. Juxtaposing** old and new structures in dialogue and without losing the value of the original structure (adding access points to the underground structures),
- 4. Staging** elements to evoke the atmosphere of a disappeared spatial layer, e.g. through integrating a walking route on the surface along the same path as the subterranean excavations,
- 5. Citing** historic elements in new places, e.g. using historic design techniques from another region to integrate into Naples' context,
- 6. Accentuating** the presence of hidden heritage through subtle spatial gestures or materials, e.g. outlining a buried element with trees.
- 7. Reactivating** a historic element's function, e.g. reconnecting an empty cistern to a water-arm to reinstall its function as a water storage

These design principles allow for the vertical and multi-dimensional nature of Naples' public space to be addressed spatially, by neither freezing heritage in place nor erasing it. In the context of this thesis, they are applied across both surface and subterranean interventions, particularly in the design of entry points, pavement details, water routes, and cooling voids. Together, these strategies support an integrated approach to archaeological sensitivity, climatic adaptation, and spatially narrating the city's heritage.

In the following paragraph, the overall design principles will inform the design strategy on each layer and then be introduced into an overall strategy for the city.

Strategy Layers

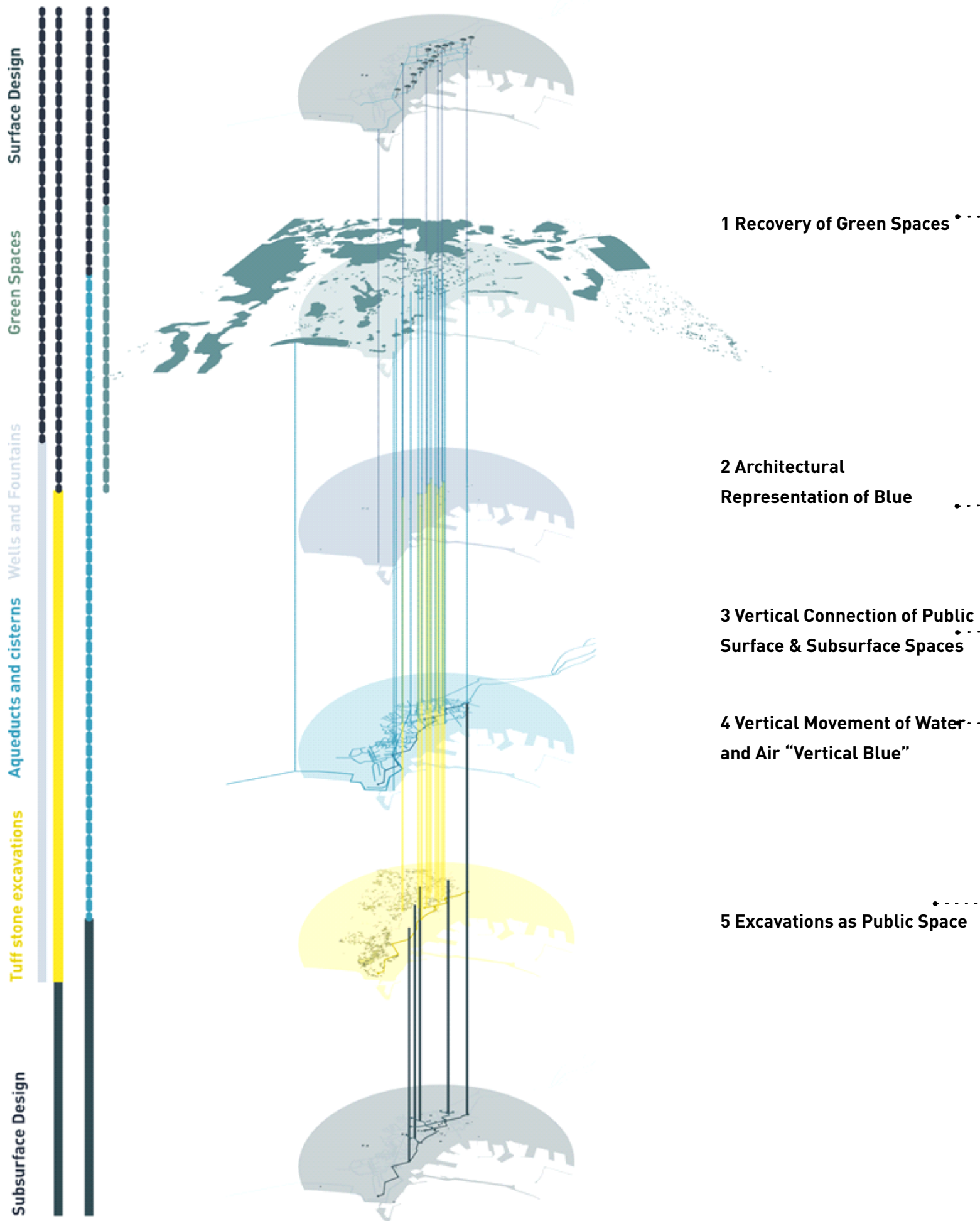
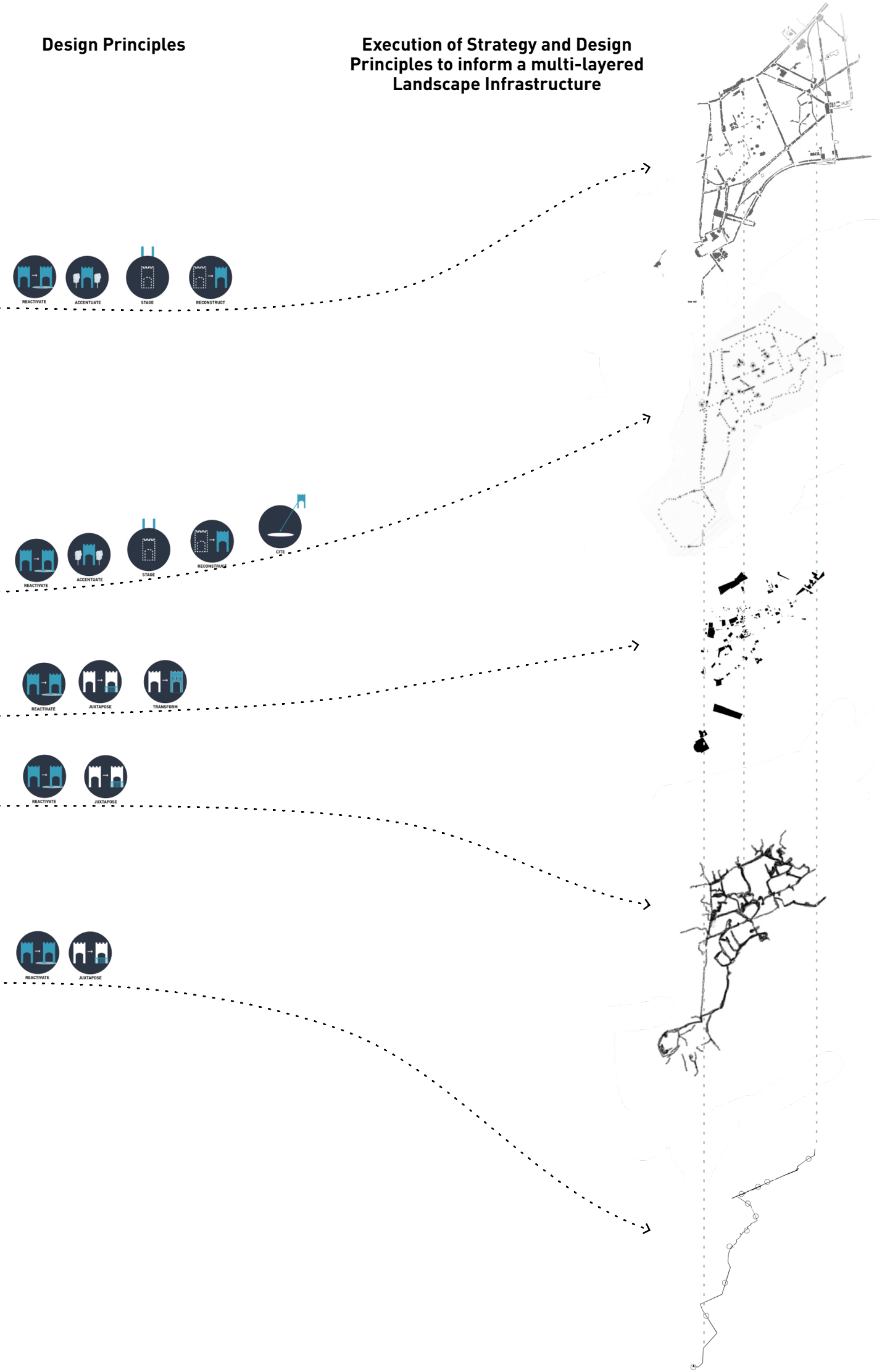


Fig. 80 Strategy Layers in relation to design principles inform the layers of the landscape infrastructure

Design Principles

Execution of Strategy and Design Principles to inform a multi-layered Landscape Infrastructure



7.2 Design Strategy Layers

These design principles will now inform the different design strategies per operational layer (fig. 80; 81)). They together form the landscape infrastructure. Designs will be integrated on each level, which includes the subterranean tuff stone excavations, aqueducts and cisterns, the metro stations, the overground architectural layer with its wells and fountains and the green infrastructure. In the end, the design interventions will be grouped into two layers, summarizing the interventions on both ends: the surface design layer and the subsurface design layer.

Strategy for the Tuff Stone Excavations

The excavations are a constellation of various subterranean voids reaching from infrastructural channels to big and wide voids with building dimensions. These once spatially, interconnected and continuous structures need improvement after a long period of neglect. As over the decades this infrastructure was subject to informal garbage deposit and sinkholes, it is time to unclog these spaces again and reconstruct or integrate new connections and openings where needed. One of the major qualities of the tuff cavities is the cool air they provide and blows through the few openings, e.g. former wells, reaching the surface. The coolness of the cavities also is an important feature to create climate shelters beneath the city to strengthen urban health. Next to that, the tuff stone itself is a porous material, that can capture humidity and seeds and therefore bring new vegetation like fennel to life. Furthermore, the warmth of the yellow tuff colour is another atmospheric factor, that provides inviting spatial conditions.

Consequently, to reach all these goals, the first strategy for this layer is to reconstruct pathways and transform the bigger spaces into usable public spaces with the potential of widening through traditional mining techniques. By reinstalling a continuous spatial network, air circulation will be assured.

Secondly, for the cool air to move vertically, reach the surface and provide the pedestrian level with a cooling infrastructure, both the surface and the excavations will be micro-needed through the juxtaposition of air-tubes in different sizes, making it possible for the cool air to reach the surface and mitigate the urban heat island effect. Besides transporting air through breathing pores, this construction is a transmitter of light, smell, sound, mental connection and sense of belonging.

Thirdly, the accessibility of the underground spaces will be enhanced through the integration of punctual stairwells and elevators to navigate between the levels and find climate shelter in short time and distance. These accessibility points will seek to be part of the built environment where possible.

Design Strategy for the Water System

Even though the aqueducts and its cisterns are also a type of tuff stone excavation, in this thesis they will be mentioned separately as they form the backbone of the landscape infrastructure and organizes the multi-layeredness of the landscape infrastructure. Along the aqueducts' lines, most surface spaces are public spaces, keeping the aqueduct and water accessible and easy to reach and tap. Many of these spaces might be voids at the moment, but have the potential to be reconstructed as water-bearing spaces where needed. The water that is currently running in some parts of the aqueducts but also outside in aquifers is 14° C cool and is an important factor to cool down the city, the people, the fauna and air. In the end, the water will be able to move vertically both ways: subterranean water will move to the top and superficial water will be infiltrated to the subsurface.

First, the idea is to make the aqueduct spaces walkable, usable and at the same time a transporter of water. Where possible, the aqueducts will be transformed into both usable

subterranean space and a parallel water-filled line within the same space. This also potentially requires a transformation of the spaces through mining.

Second, similar to the Moroccan model, through the height gradient within the aqueduct running from higher East plains to the coast in the West and generating a gravitational pull, water pressure will develop and push the water up to the surface. Next to water pressure as a non-invasive method, juxtaposed pumps will support the system to move it from the depths of the subterranean world to surface-level. Similar to the breathing pores that are being introduced for the tuff stone voids, fine water transporting tubes will be acupuncture to tap water for surface use and accentuate the public spaces through mist, waterplays, fountains and water bodies.

Third, the superficial water can also enter the aqueducts and cisterns to be stored for water scarce, dry and hot periods. This water storage function is crucial to assure the cooling down of both the surface and subsurface world. Whether if it is about reactivating the fountains for people and fauna to cool themselves down on a day of 40° C or maintaining the irrigation infrastructure for the urban green structures. Furthermore, by keeping the tuff stone humid on a controlled level, the cooling capacity of the underground thereby will also be maintained.

Design Strategy for the Metro Stations

The metro stations' function is supposed to be providing stepping stones between the surface and subsurface level. They are physically connected to surface level but the city of Naples never anticipated an actual connection with the subterranean world. Through building the metro stations, many subterranean findings were made. However instead of embracing the subterranean landscape of aqueducts, cavities and connectivity, they kept these two worlds separate, continuing the neglect of this world. Historical findings they made during the building process are exhibited, e.g. showcasing historic elements behind glass walls. However – like with any contemporary infrastructure introduced into Neapolitan grounds – they were again penetrating the complex and rich subterranean layer without acknowledging or integrating its actual qualities.

The strategy therefore is to create connections between the metro stations and the cavities. They can also be the important connecting infrastructure for maintenance works. More than that, inhabitants and travellers move through the metro stations every day, so the connection to the subterranean world would also be part of their everyday routine.

Design Strategy for the Architectural Layer

The next strategy layer is the architectural layer which consists of wells, fountains and the volcanic stone paving. There used to be many more wells throughout the city and technically it used to be possible to enter one well, cross the city underground, and exit via another well (Hydria Virtual Museum, n.d.). Most of the still existing wells are hidden in private or collective courtyards, oftentimes part of cloister complexes, and therefore are inaccessible or only accessible through payment. The majority of spaces around the wells are mostly lush and green places, so it seems that these spaces can be maintained via the wells again when reactivating the water infrastructure. As these places are hard to reach for public use, similar well types and well functions should be introduced into the public realm. Either for providing air, cool water or access to the underground.

Consequently, the existing wells should be reconnected to the water system to reinstall their original function as water provider. The public spaces will be equipped with (re)constructed wells that inherit either the original function of water transportation, will be transformed into an access point or, similar to the breathing pores, will function as a bigger opening exchanging light, water, smell and sound.

1 Recovery of Green Spaces

3 Vertical Connection of Public Surface & Subsurface Spaces

2 Architectural Representation of Blue



**4 Vertical Movement of
Water and Air “Vertical
Blue”**



Fig. 81 Strategy Layers decomposed

Furthermore, many fountains are part of the public, collective and private spaces. Some of them still run water, others are restored in form but not in function, and then there are many inactive ones with signs of decay and vandalism or are closed off behind fences.

The first step for the existing fountains is to reconstruct them and reinstall their form and function as a social and acoustical element that accentuates certain public spaces again. Like in Naples' past, the fountains become a meeting place again. Additionally, their ornaments and figures tell stories about the past and therefore its important to accentuate them with the water function again and draw the attention of passers-by.

The second step is to integrate new subtle fountains, water elements and waterplays into the city to accentuate public spaces along the aqueduct line that are worth being requalified. Brining the water from the subterranean aqueduct into the surface spaces is essential as it fills the spaces with curiosity, calmness and continuity in sound within the irregularity and chaos of the city. These are the "touchable" and physically accessible water elements that follow the line of the aqueduct and occur on every corner where accentuation is important.

The idea of reintegrating water elements into the public spaces refers back to the hypothesis of water being the answer for a spatially limited and highly sealed urban context. The spaces that are being reactivated by water are narrow, UNESCO protected and neglected. As there is hardly any space for green anymore, water features are a space-efficient solution to these places, giving space for the assembly of people, exchange and temporary use.

Furthermore, referring back to the examples from Venice, some of the (reconstructed) wells and fountains can not only be reconnected to the subsurface but also be requalified as a micro-scale water storing and purifying plant that captures on-spot water, filters it through clay chambers and provides drinking water as an output.

Moreover, Naples is characterized by black volcanic stone paving, creating a dark and mystic atmosphere in the narrow city streets. They are telling the eruptive and transformative story of Naples and its volcanic landscape. In order to follow the path of the water system through the city, small high-visibility stones will be strayed into the blacks and greys of the ground, providing a tactile, subtle but readable element, guiding the inhabitants and visitors along the story of Naples' water heritage. This design approach cites the urban paving design of the ancient city of Pompeii, where moon stones in a lighter colour were integrated as a contrast to the darker paving, to ensure visibility and navigation by night.

Design Strategy for the Green Layer

The fragmented and oftentimes hidden green layer in the city center still holds a high potential to contribute to the cooling, biodiversity and liveability of Naples. This strategy focuses on micro-green structures that can be reactivated, expanded and climatically improved through the integration of water and spatial transformation. Micro-interventions become key to establishing a functioning green infrastructure as in the compact ancient city of Naples, areas such as parks or linear green corridors are spatially impossible to establish. The green infrastructure therefore seeks to be integrated following the lines of water, staging the aqueducts presence within sequences of public spaces, while the more private green structures are being reinforced in their climatical and ecological value.

First, the concept of the wetter micro-green spaces along the line of the aqueducts becomes central. As identified, cloister spaces, collective and private courtyards are spread out through the whole city and often connected via a well to the subterranean voids or aqueducts. By reintroducing and channelling water into these spaces and former green courtyards, valuable ecological conditions will be created for more stable micro-scale ecosystems. These sites become not only visually appealing again but can also be hotspots of urban biodiversity, especially for fauna like birds and insects, trees and shrubs, small flora, mosses, grasses and local herbs such as fennel that are known to thrive in tuff environments.

Secondly, this strategy aims to establish a connected micro-climate network between the underground and surface via vertically moving water and air, humidity and greening. Micro-gardens will be placed in strategic spots along the aqueduct line and in climatically exposed spaces to act as cooling nodes. Their cooling performance will be increased by linking them to the breathing pores and well structures described in the previous chapters. In some spaces directly re-moistened tuff lets the material itself act as both substrate and moisture reservoir.

Third, more green infrastructure will be integrated or recovered for valuable shading. Where public space and subsurface structures allow, trees will be reintroduced into the public realm, especially along the flow of water as an accentuating feature. Following the line of the aqueduct, they visually and ecologically guide the public through the layered system beneath, forming a green spine that connects microclimates along the route. These trees not only provide shade and cooling through transpiration, but together with water elements and cool air from below, they create a complete, healthy and layered climate on the surface.

Introducing more water into green spaces, especially in combination with cool air or water coming from the wells and being stored in porous materials like tuff stone, can allow for more evapotranspiration and spontaneous vegetation growth.

7.3 Symbiosis of the Design Strategies

The design strategy of "Vertical Blue" (fig. 82) is based on the principle that the resilience of Naples depends on interconnecting the subterranean and surface worlds into a continuous and interactive system. Rather than treating each layer in isolation, the strategies for water, air, green, tuff stone excavations, and architectural elements are designed to reinforce one another. Together, they form a symbiotic network that improves spatial quality, ecological performance, and social inclusivity.

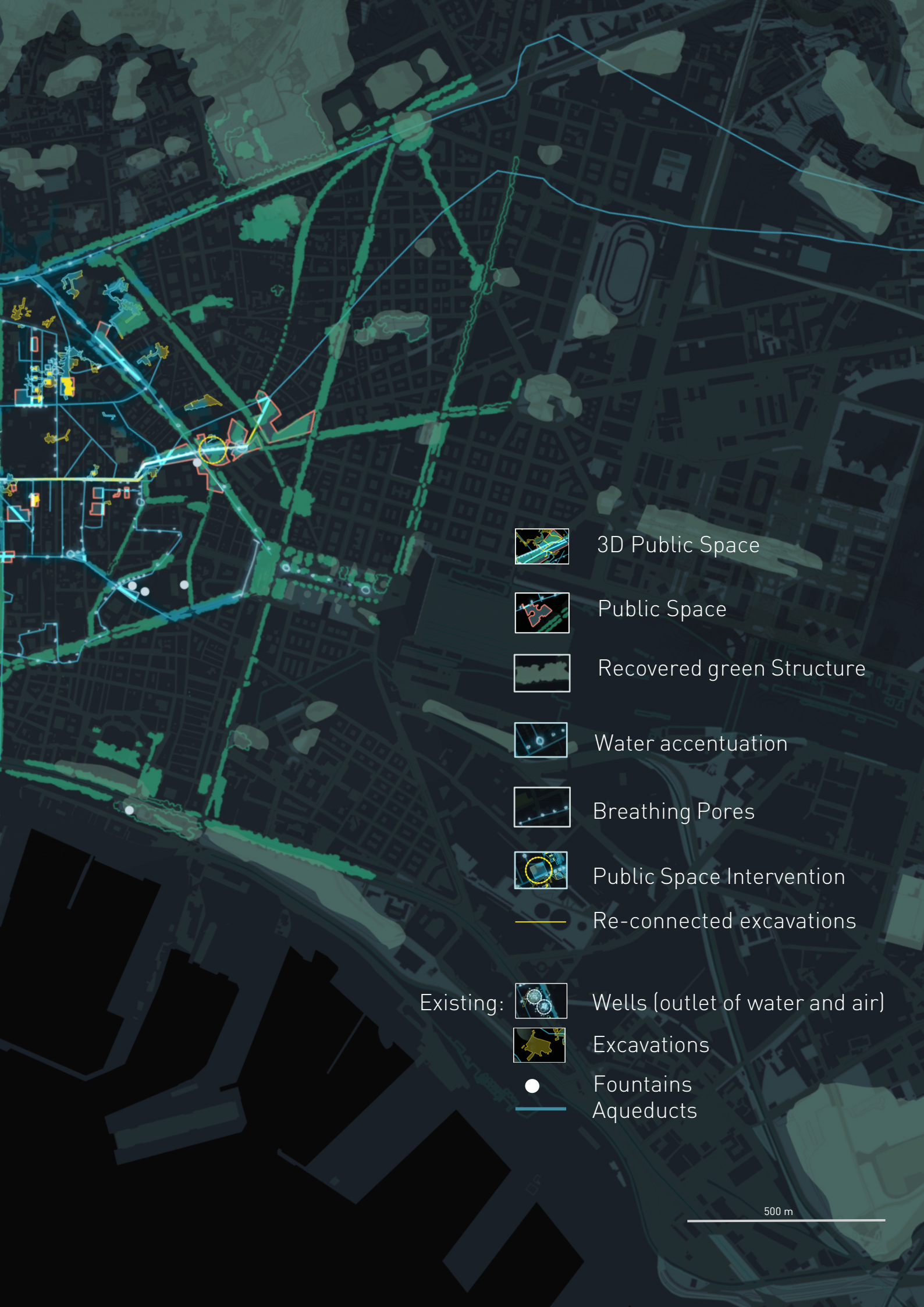
Water becomes the structuring element that organizes surface and underground movements, linking wells, fountains, and cooling spaces along its path. The tuff stone excavations, reopened and ventilated, create a subterranean spatial network that supports air circulation, thermal comfort, and climate sheltering. Green structures above ground enhance these effects by shading public spaces, reducing radiation, accentuating certain public spaces and improving ecological connectivity. Newly introduced and connecting elements, wells and metro stations serve as access points that physically and mentally connect the levels, allowing the movement of people, air, and water between surface and subterranean spaces.

Through this interplay of layers, the design transforms the fragmented historic center into a breathing, living landscape. Surface and subsurface interventions work together to generate new micro-climates, activate public spaces, and create a multi-dimensional urban environment where water, air, vegetation, and people are bound together into a coherent and resilient landscape system.



Fig. 82 Strategy for the City Center of Naples set up on landscape-based system

Map created by Regina Klinger, TU Delft using data provided by: Google (2024), LAN/CoolCity, Geofabrik (2024), LAN/CoolCity, Manuel Orabona, Istat (2011), UNESCO, Comune di Napoli (1967)



3D Public Space



Public Space



Recovered green Structure



Water accentuation



Breathing Pores



Public Space Intervention



Re-connected excavations

Existing:



Wells (outlet of water and air)



Excavations



Fountains
Aqueducts

500 m



8

Design Exploration

Following the spatial analysis and theoretical background, this chapter translates the research into a concrete design. The design approach was broadly introduced with a strategy at the city scale, defining overarching principles for reconnecting Naples' surface with its hidden water systems. From there, the scope narrows down into the vision "Vertical Blue" that gets concrete in the masterplan, outlining targeted interventions along the historical aqueduct. A sequence of spaces above and below ground demonstrates the reactivation of public spaces along the line of water, reconnecting historical infrastructure with contemporary urban needs. Finally, the chapter zooms into the Eastern entrance gate Porta Capuana, illustrating in detail how these concepts can materialize through specific, place-sensitive design interventions.

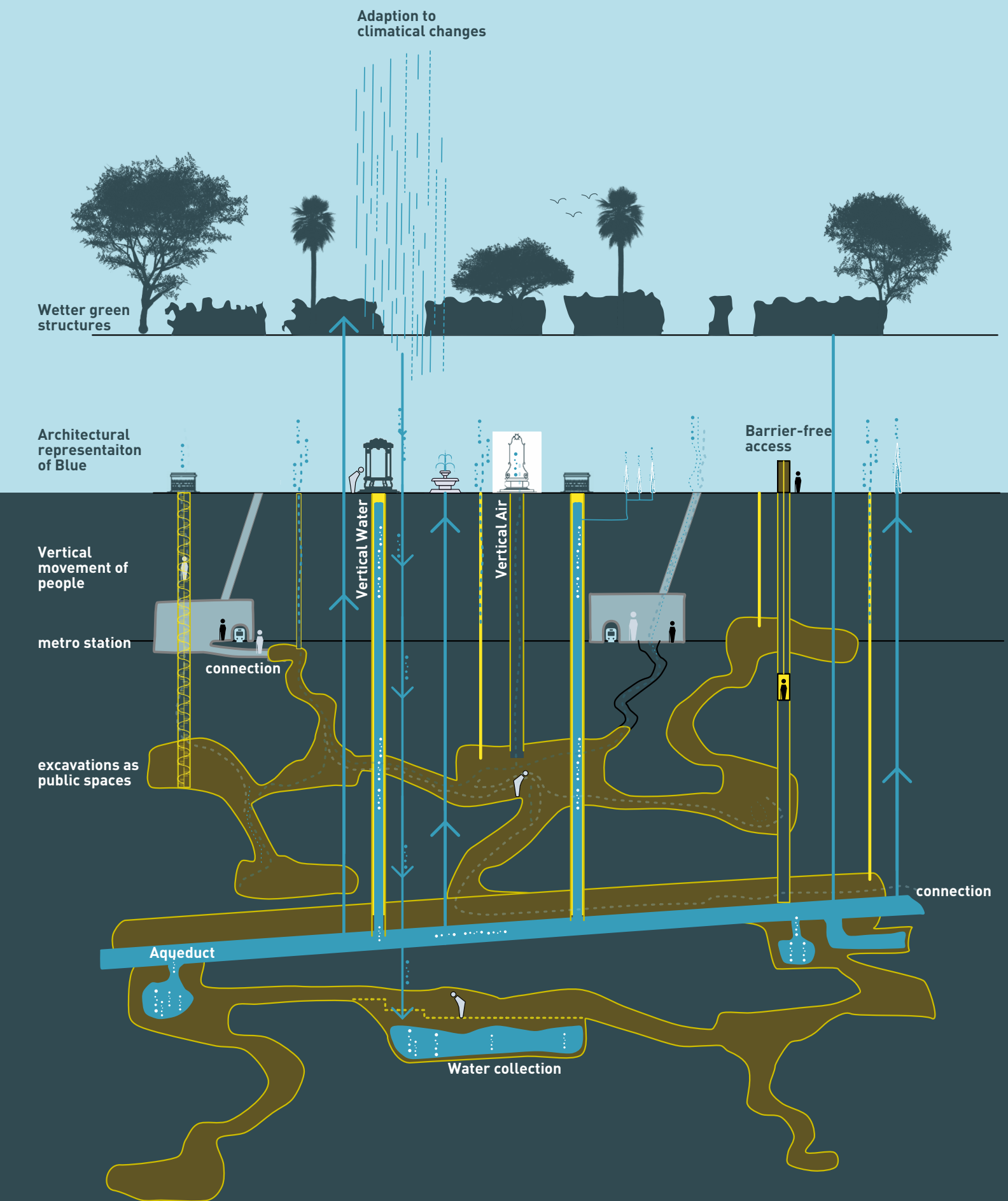


Fig. 83 Concept of "Vertical Blue"

8.1 Vision “Vertical Blue”

Referring back to the strategy for the city, this thesis is about creating a landscape infrastructure through vertical interconnection along the line of the subterranean water system. The overall vision “Vertical Blue” represents the vertical movement of water, cooling air and humidity, all elements deriving from or related to the water system (fig. 83). The vision for the city center in Naples is therefore to realize surface and subsurface public spaces through the symbiosis of excavated voids, aqueducts, architectural elements and micro-green infrastructure. On the one hand, it is about reimagining these elements creating an urban metabolism, a breathing city organ, where coolness flows from the depths to the streets, bringing thermal comfort, social connection and spatial continuity. On the other hand, it is about daring to introduce water into the underground spaces for cooling and storage purposes.

This reconfiguration does not seek to add generous new layers to the city, but rather to re-activate the forgotten ones through micro-interventions and link them with the everyday life of its inhabitants by including flows and processes (Nijhuis & Jauslin, 2015). “Vertical Blue” becomes a symbol, a blue line of reasoning, to establish a climatic and social dialogue between past and future, architecture and landscape, dryness and wetness. This vertical system consumes minimal land while enabling a maximum of environmental resilience, ecological and social return. Instead of freezing the heritage or excluding it from the dynamics within the city, the vision demonstrates how layers of history and archaeology can become operational layers again. In doing so, this vision provides a model for how historic cities can use their limited space through re-discovering their vertical complexity as a landscape infrastructure to adapt to critical climatic, ecological and social challenges.

8.2 Masterplan

The Masterplan therefore incorporates the vision for the city on several operational layers. The excavation layers will become walkable public space structures, the aqueducts will be running water and become public space as well, the wells, fountains and surface paving will reach down through water and air pipes to the underground system creating a transmitting medium and the green infrastructure will benefit from the water being pumped up for irrigation and also enhance the forgotten system, accentuate the appearance and strengthen the effects of the upcoming vertical blue elements.

8.3 Design of the landscape infrastructure at Porta Capuana

With the strategy addressing the whole city center, a masterplan of one selected area, Porta Capuana, will be worked out in detail. Applying the strategies through the design principles while addressing the challenges mentioned, the Eastern entrance to the city on both levels will be showcase how the landscape infrastructure operates.

To illustrate that the water system as landscape infrastructure can bring better conditions to the public spaces within the city center of Naples, the urban square Piazza Enrico de Nicola with the former entrance gate Porta Capuana is an interesting design site. Having been subject to radical urban transformation processes from 2017, including the complete removal of giant city trees formerly covering the site, creates already an important starting point on surface level.

What makes this area suitable as an intervention site for this thesis, however, is the former function as the entrance point of the Bolla aqueduct that still lies right beneath the surface on 13m above sea level. Alongside it, hidden cistern spaces (fig. 84) are located beneath the church Santa Caterina a Formiello and the former wool factory (LAN/CoolCity, 2025).

A forgotten, neglected and inactive fountain monument, the Fontana del Formiello used to mark the entrance point of the aqueduct in the historic composition of this square and is still present attached to the backside of the former castle Castel Capuano. The fountain faces the public space around the entrance gate and the church.

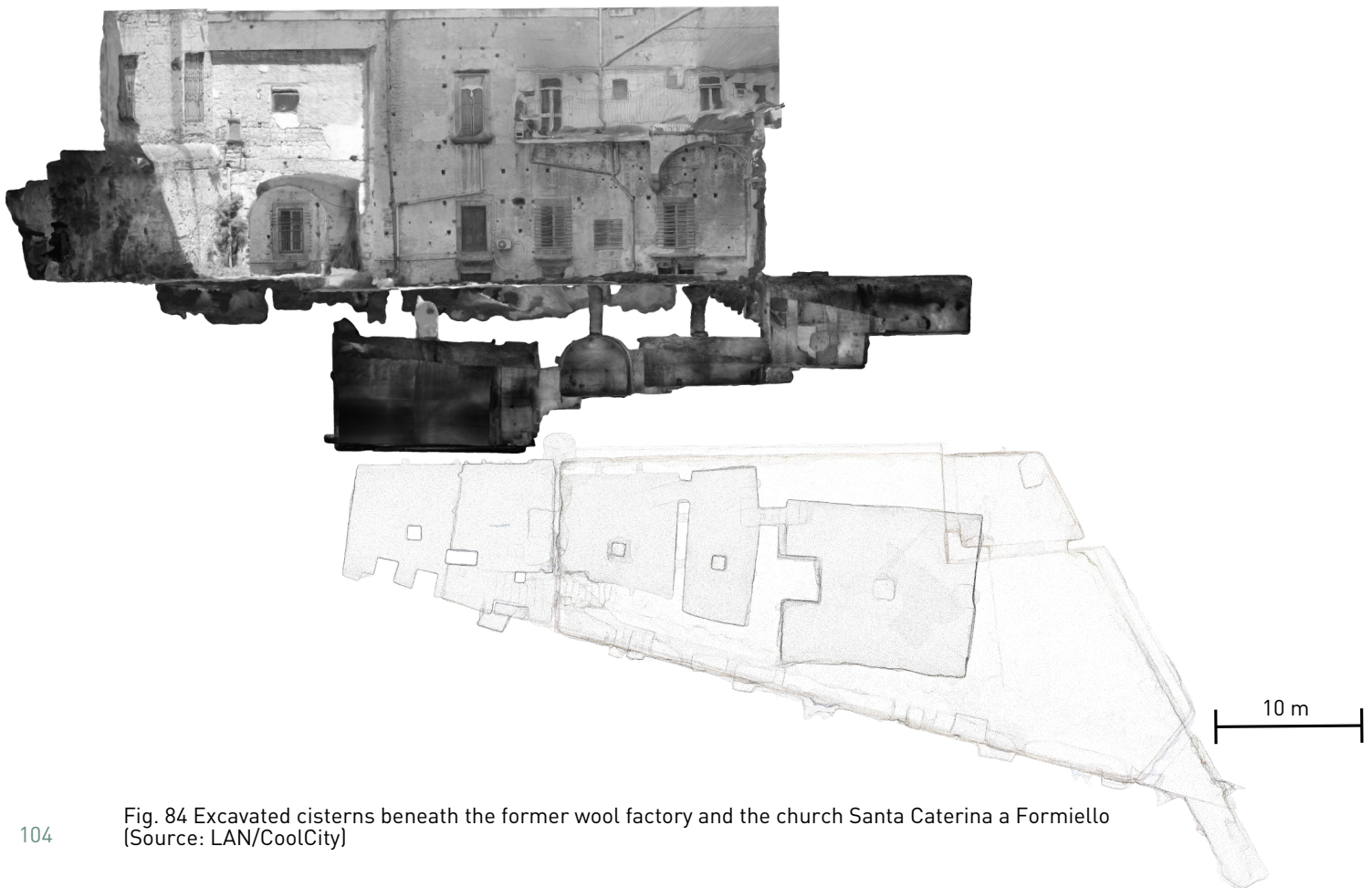
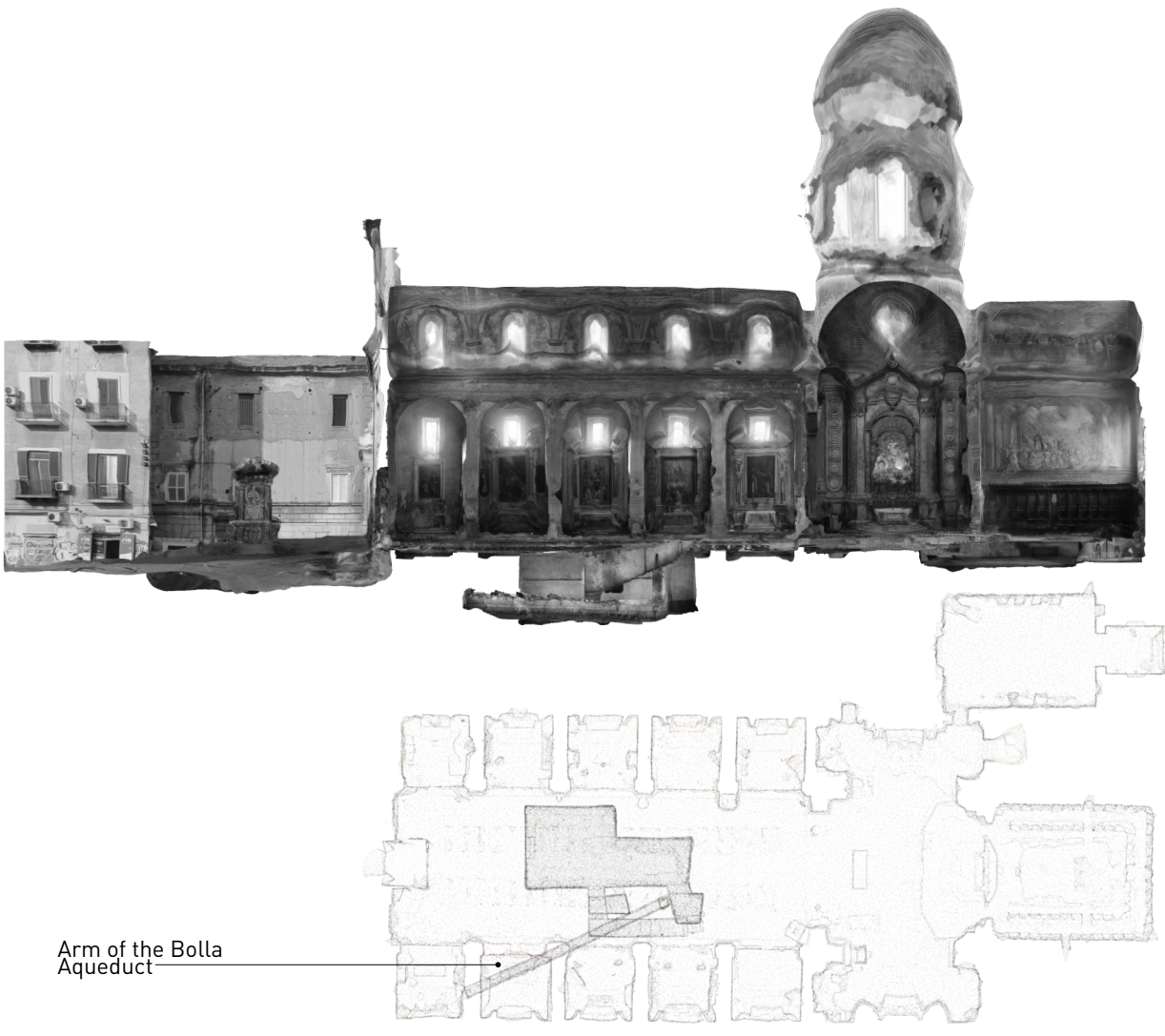


Fig. 84 Excavated cisterns beneath the former wool factory and the church Santa Caterina a Formiello
 (Source: LAN/CoolCity)

Furthermore, through the research and photogrammetry measurements by LAN (laboratorio architettura nomade) and their initiative CoolCity, it became evident that beneath the church and the former wool factory, the cisterns are filled with water. Especially the church's cistern is visibly connected to the Bolla aqueduct through a side arm reaching right beneath the surface of Piazza Enrico de Nicola. It is not clear where exactly the water arrives from but there is a high chance of water coming via the aqueduct's structure that wraps its branches around the area of the square and cisterns. The entrance gate itself lies in a depression and especially around the towers are open water shafts where water will be captured, indicating a water transportation system leading into a cistern system. The gate extends northwards via the former fortification wall, which as well, inherits some cisterns, visible from above.

The main access route to Porta Capuana served as a connector to regional and commercial flows. The gate is named after its orientation toward the city of Capua and was constructed in the late fifteenth century with an architectural composition of a white marble arch and sculpted bas-reliefs, illustrating Roman triumphal arches while retaining a defensive role in response to the military tensions preceding the war. Two cylindrical towers left and right of the arch form the gate, symbolising Honour on the left and Virtue on the right. These elements were part of a broader fortification system that extended northward. Nearby towers, remnants of the former city wall system, are still visible in adjacent streets but have largely fallen into disrepair.

As aforementioned, the site has changed not only due to recent contemporary urban planning decisions but also over the centuries. The Map of Duca di Noja from 1750, similarly set up like the Nolli Map, represents a façade of Naples, marking the gardens and semi-open spaces. It clearly shows a green garden city with architecture interacting with the street and public spaces. It becomes evident that this urban square once used to be enclosed and framed by the fortifications, the church, the castel and another plaza Piazza della duchesca. The aqueduct's entrance point was a stand-alone piece of architecture, subdividing the square into Piazza dei Reg. Tribunali and Piazza della duchesca.

Within the scope of this project, the site is re-examined as a layered threshold and connecting node towards the city center of Naples, that links surface dynamics with the underground water system known as the Formale Reale, the main channels of the Bolla aqueduct (Gentilcore, 2019). This layered understanding forms the basis for the design interventions outlined in the following sections.

Excavation Layer

On the excavation level, especially the voids of the cisterns, the distributing arm of the aqueduct and the aqueduct itself are going to be addressed. The voids provide cool air as they lie buried beneath the city, are fed with water or store humidity within the tuff stone walls. Through the design, they will again provide a continuous spatial system that can run water and let people walk through the cavities. Interrupted or clogged parts will be reconstructed and cleared. Furthermore, the cisterns will be reactivated as water storage, providing water in dry, hot and water scarce periods, moving vertically towards the surface to irrigate vegetation and cool the people through water features.

The void of the aqueduct will be reconstructed into one spatial continuum reaching into the direction of the city center. Through widening the space by carving out small amounts of tuff stone, the space gets a dual function, similar to De Ruinen in Antwerp, a waterway and a pathway, and can open up more to provide underground functions like a café or bar and serve as point of encounter and climate shelter. Small air pipes will be introduced into the surface reaching down towards the cavities, tapping the cool air to bring it up to the surface. The air shafts not only provide air, but depending on their size and depth also serve as a transmitter of light, sound, music, smell and small fauna.

In the backyard of the former wool factory, the cisterns will be reactivated and equipped with pumps to move the water vertically.

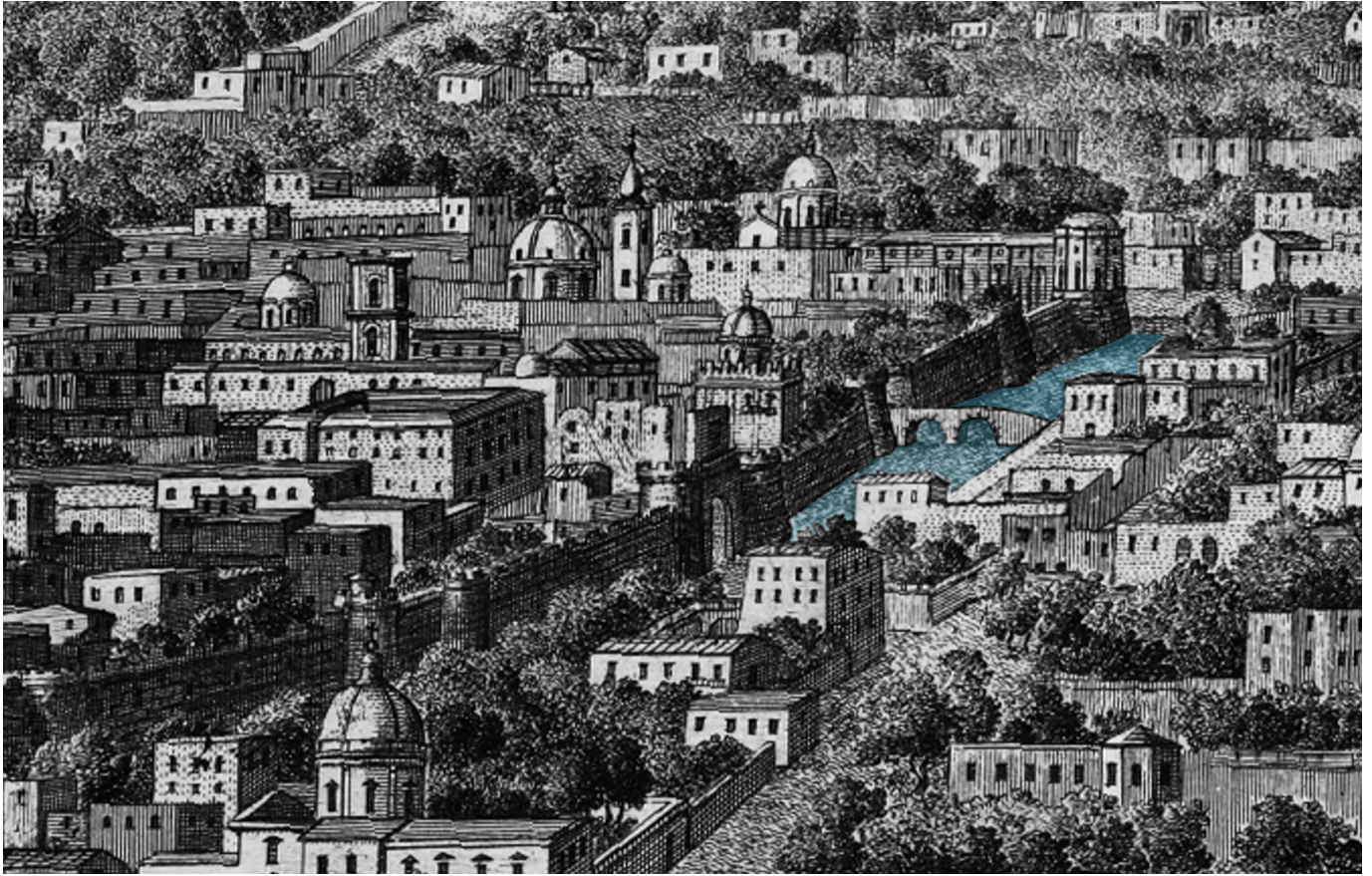


Fig. 85 Insights into the former presence of rivers, water and extensive green structures around Porta Capuana through the Duca di Noja Map from 1750

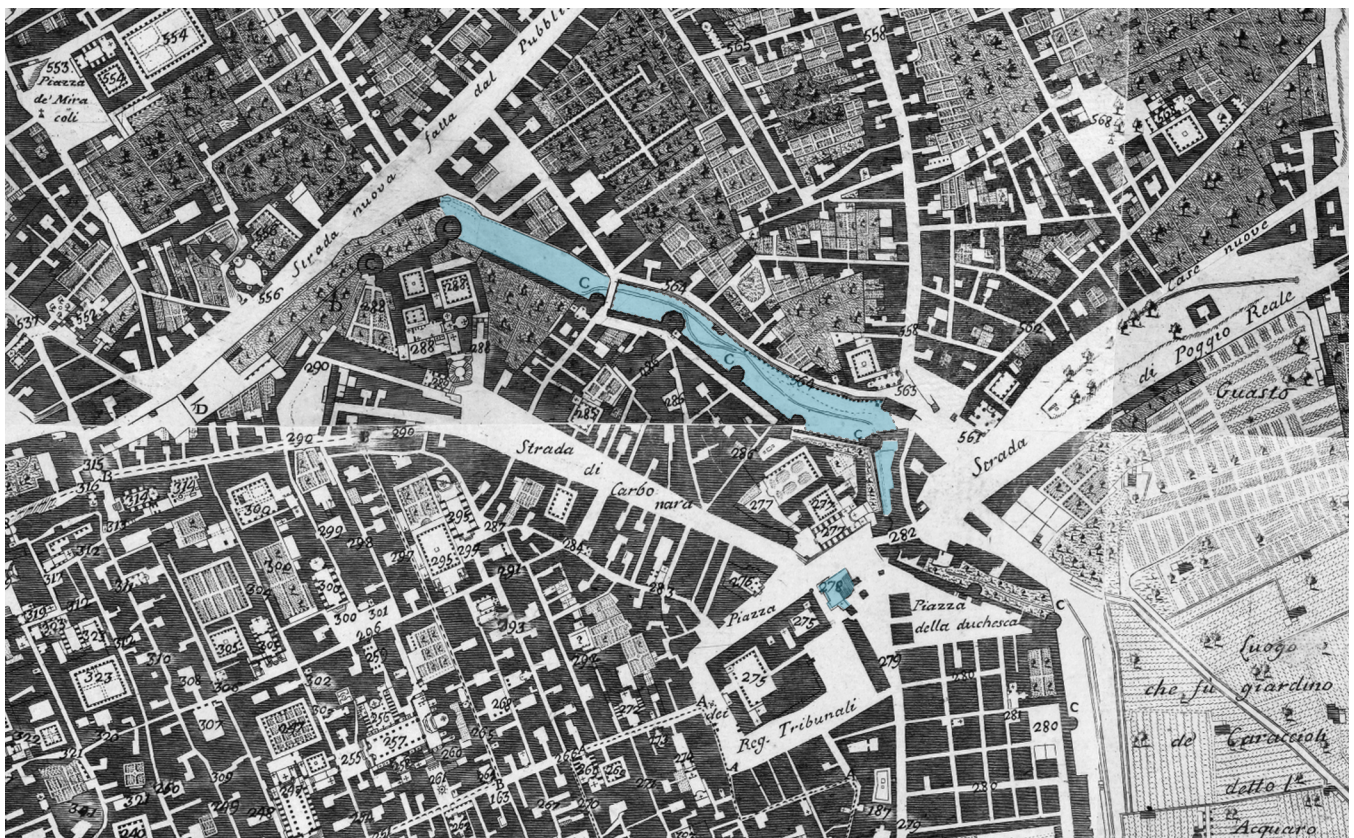


Fig. 86 Former river path and water monument (278) marking the entrance of the Bolla Aqueduct

100 m



Fig. 87 Former modern green history of the area around Porta Capuana before the year 2017 [Source: Berthold Werner, 2013]



Fig. 88 Former modern green history of the area around Porta Capuana until the year 2017, where the majority of all green structures were cut down [Source: Google Earth]

100 m



Fig. 89 Current surface situation at Porta Capuana: Heavy impact through traffic, exposed to sunlight and little shading through lack of vegetation



Fig. 91 Current Situation at Piazza Enrico de Nicola next to the Church Santa Caterina a Formiello



Fig. 90 Current Subterranean Situation at Porta Capuana in relation to urban green and public spaces



Fig. 92 Current Situation at Porta Capuana looking to the West

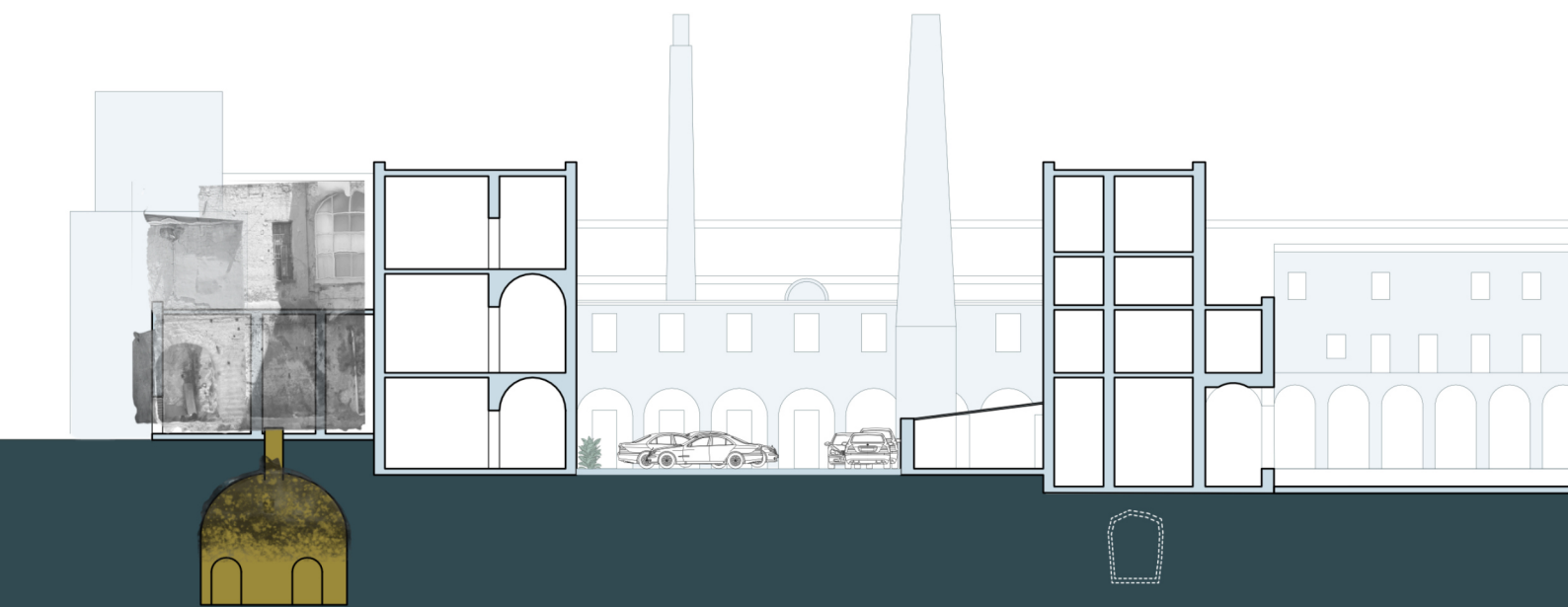
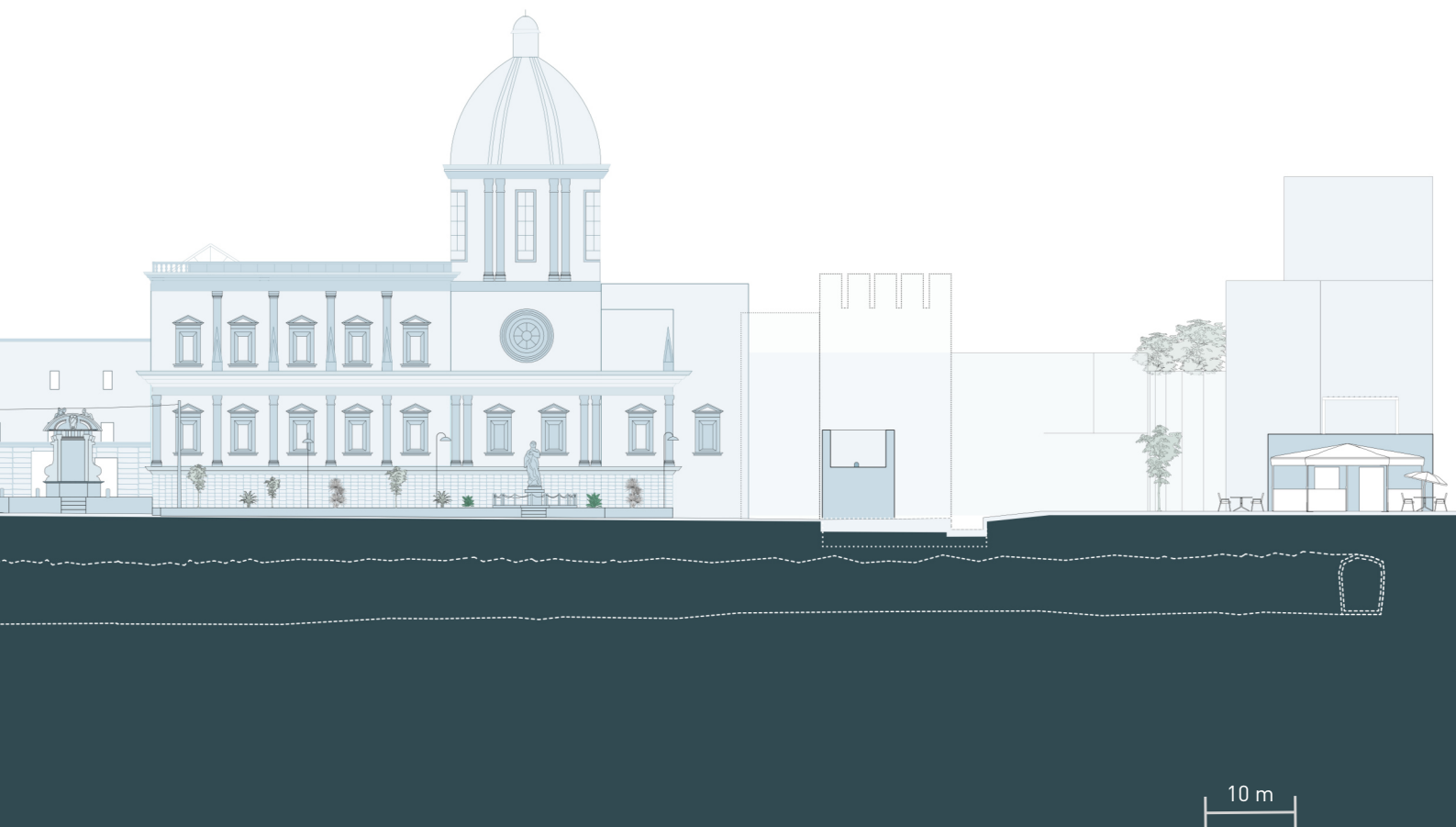
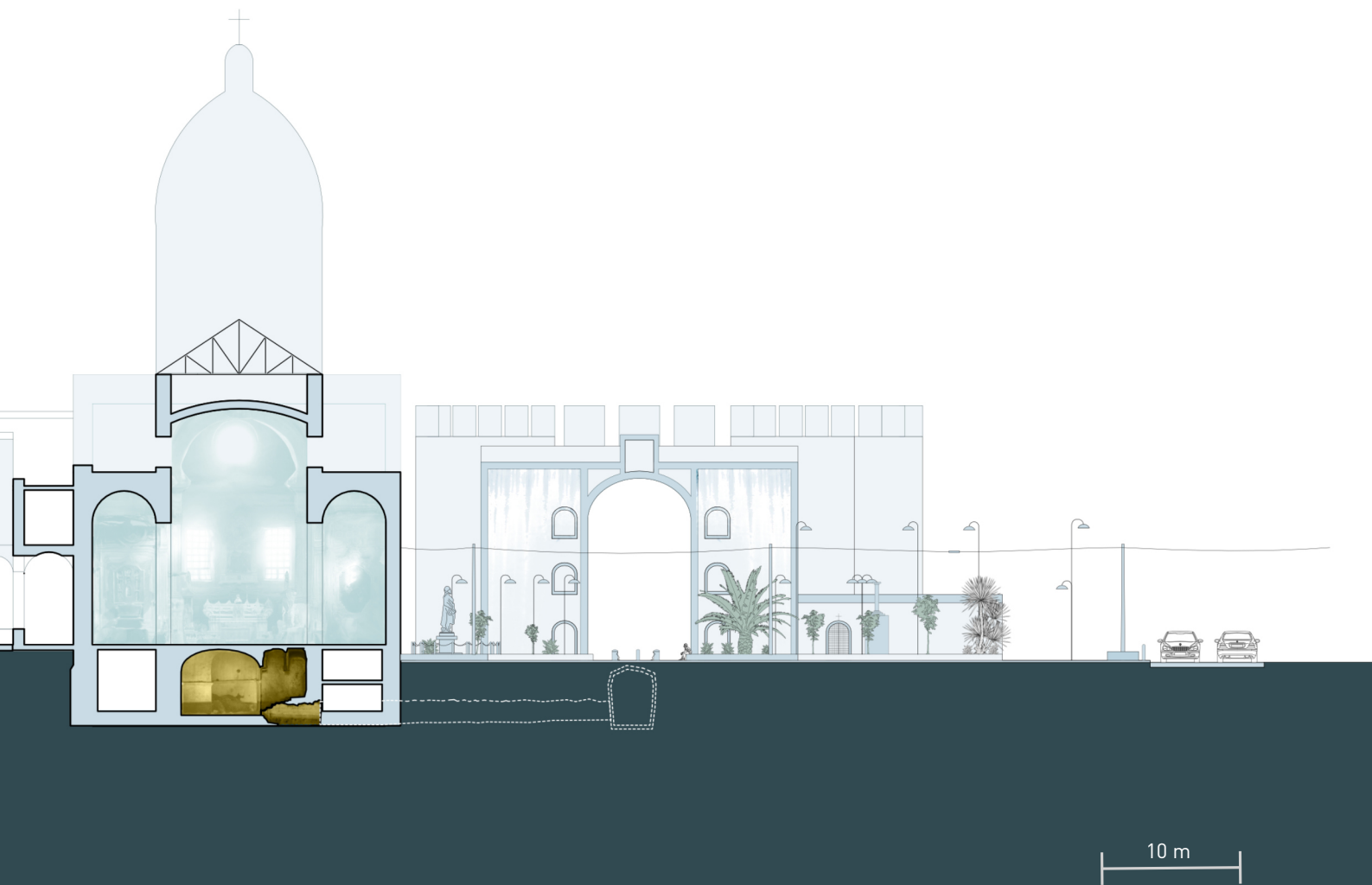


Fig. 93 Current Situation at the former wool factory complex with the indication of the position and potential existing form of the aqueduct



Fig. 94 Current Situation in the threshold zone from entering porta capuana in the east and walking towards the city center



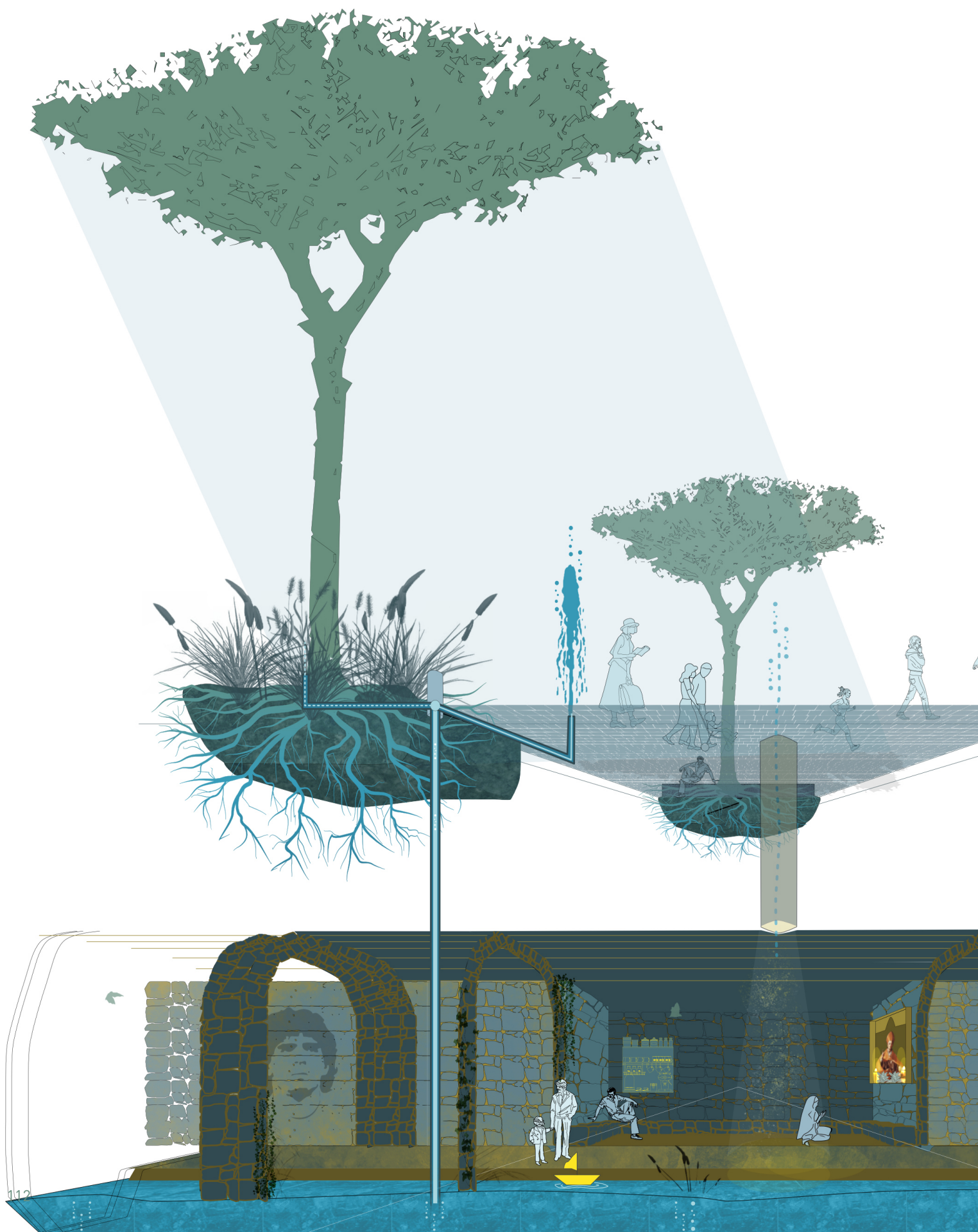


Fig. 95 Creation of a three-dimensional public space with spaces for leisure, social interaction, place-making, prayer, intimacy and ecological processes

Water Layer

First of all, the aqueduct system, especially the Bolla aqueduct (fig. 99) between Mount Vesuvius and West-Naples will be reactivated. Its water will move up vertically through acupuncturally juxtaposed pipes equipped with pumps. At Porta Capuana it is bringing up the water from the cisterns, via the aqueduct to the public space where it reactivates the fountain Fontana del Formiello.

Additionally, through micro-needling the surface with water pipes, these vertical channels will reach the soil of the vegetation (fig. 95) for irrigation purposes but also small water pipes will be introduced into the surface to add playful water elements. Misting nozzles, similar to Utrecht's Domplein by OKRA, will be placed around the towers to represent the former wetness and mysteriousness of the place and enhance the threshold atmosphere that it once had.

In the backyard of the old wool factory – currently a parking lot – the former cloister gardens are being reinstalled through vertically introducing the water to the surface-level from the cistern lying right beneath the surface.

Architectural Layer

On architectural level, the micro-needling of the pavement is a first step to bring the subterranean world to surface level. The differently sized openings of the pipes for water, air and mist wander along the line of the aqueduct, tapping its resources of cool water, air and humidity. Additionally, to stage the line of the aqueduct, white reflective stones (figs. 96; 101; 103), citing Pompeii's urban streetscape, in combination with traditional ornamental Neapolitan tiles, are going to be introduced into the new stone paving around the square and also, when reaching the city center, be placed between the characteristic black basalt lava stone. They are made out of marble, using the same material as the Capuan gate's arch and the stones from Pompeii. They not only represent a walkable water story on the surface but they function as well like in ancient times: as a guiding and tactile element during the night, when the moonlight gets reflected on the stones for better visibility and orientation.

In the backyard of the former wool factory, a usable fountain will be integrated, creating a contemplative, continuous acoustic element, relying on the aqueduct's history. It is set up similar to the wells in Venice, as the fountain gets the on-spot function of water collection and filtration and can either provide the collected water to the surface through the fountain or gets drained into the aqueduct's arm situated between the two cisterns (fig. 97).

Additionally, the small one-floor building "Bar delle Torri", which is placed right before entering the gate from the east, will be transformed into an access point to the subterranean cavities. This corner-building will be turned into a round-shaped dwelling while keeping its

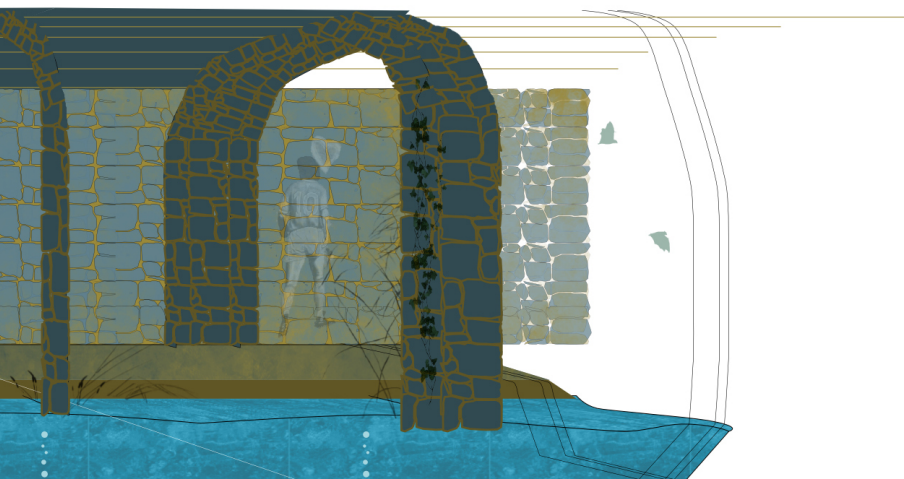
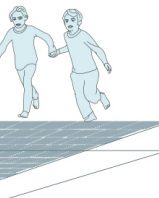
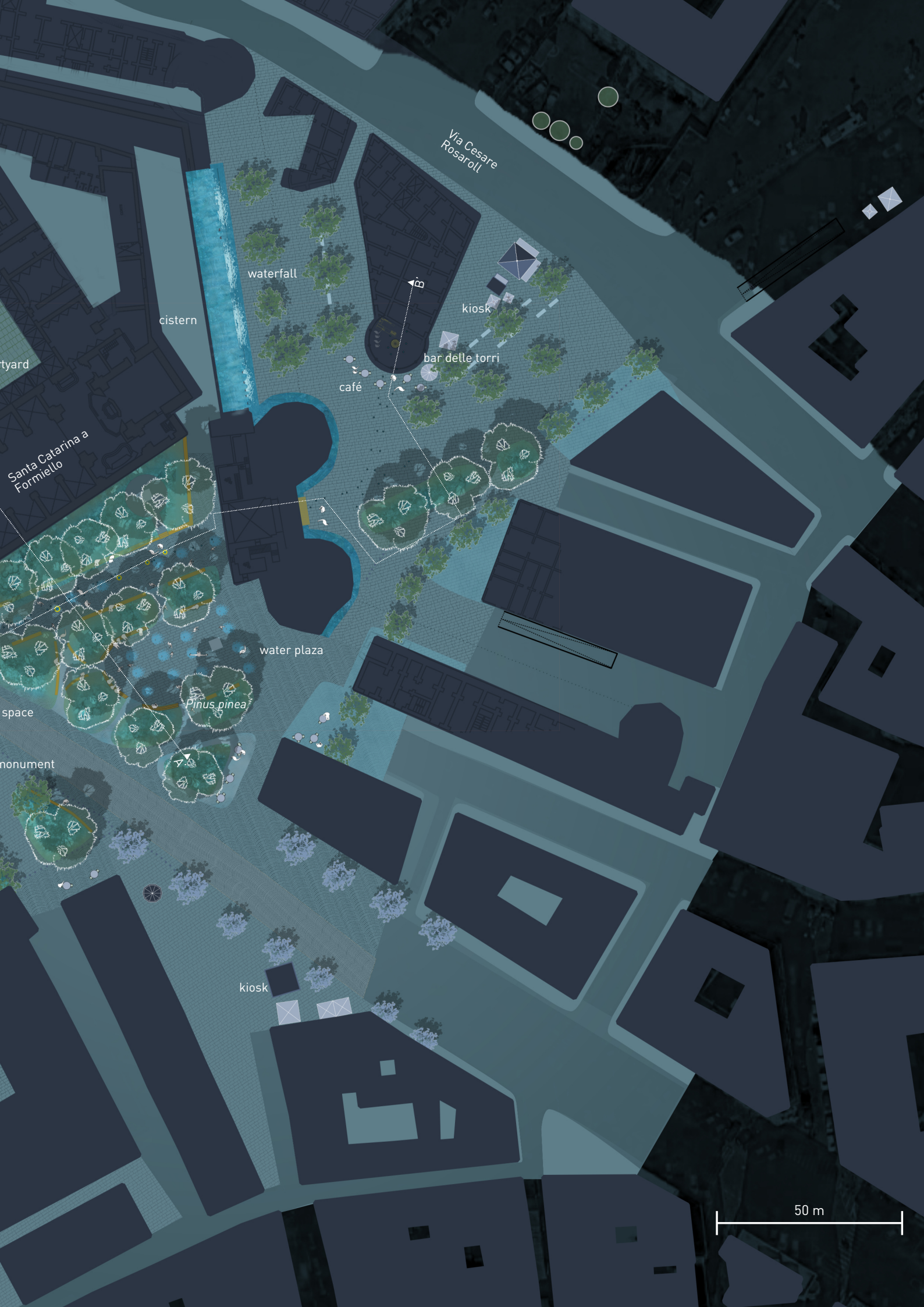




Fig. 96 Masterplan Porta Capuana - Surface



Via Cesare
Rosaroli

waterfall

cistern

kiosk

bar delle torri

café

water plaza

Pinus pinea

kiosk

50 m

use, creating an ensemble together with the round-shaped towers of the gate. The building's transparency draws attention to passers-by and gives a glimpse of the stairwell leading towards the underground spaces (fig. 103).

As the busy street of Via Carbonara/Via Alessandro Poeiro currently cuts through the space continuum of the square, it will become a shared space, being marked through a continuous pavement structure with tactile ripples, signalling to slow down.

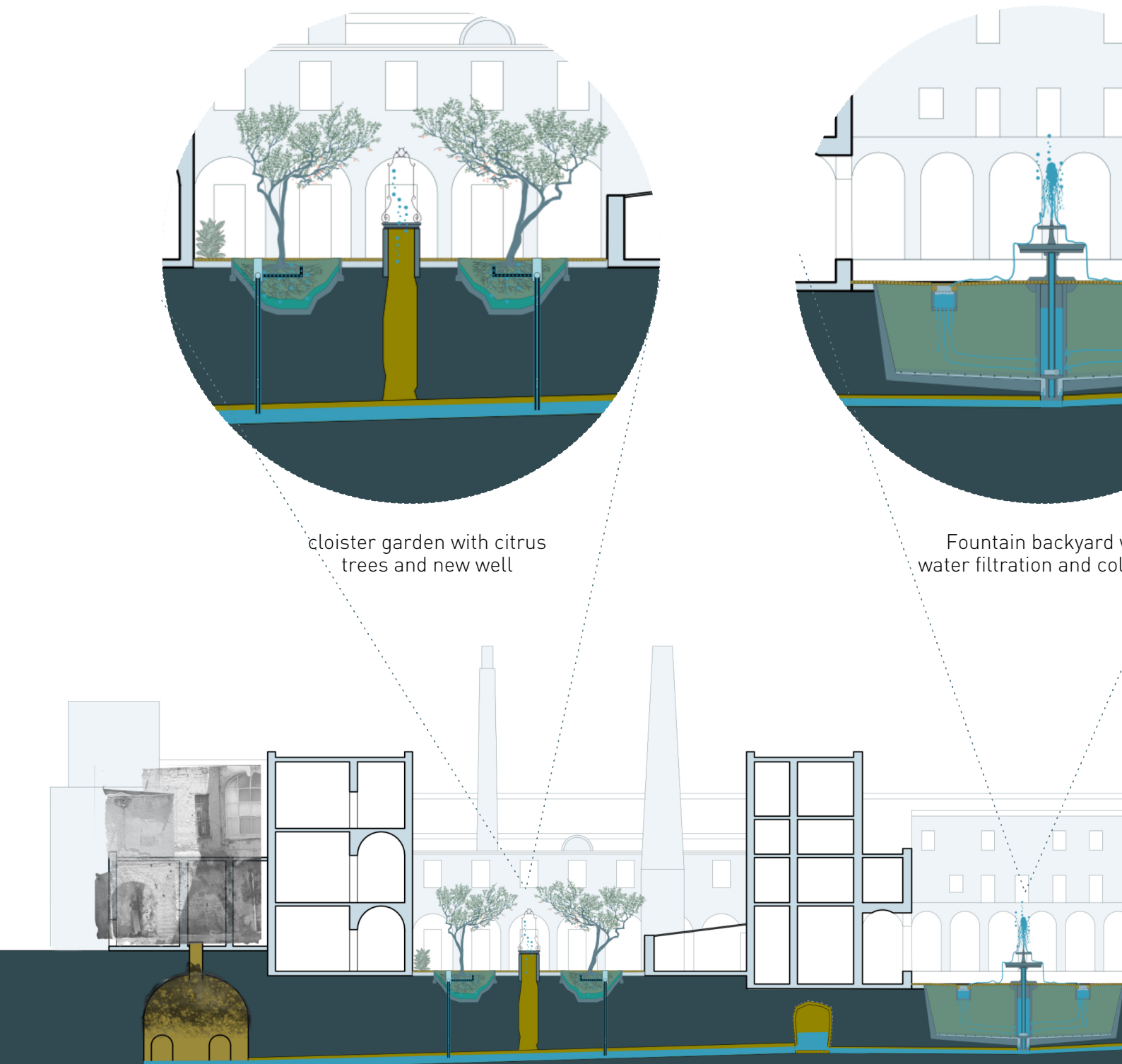
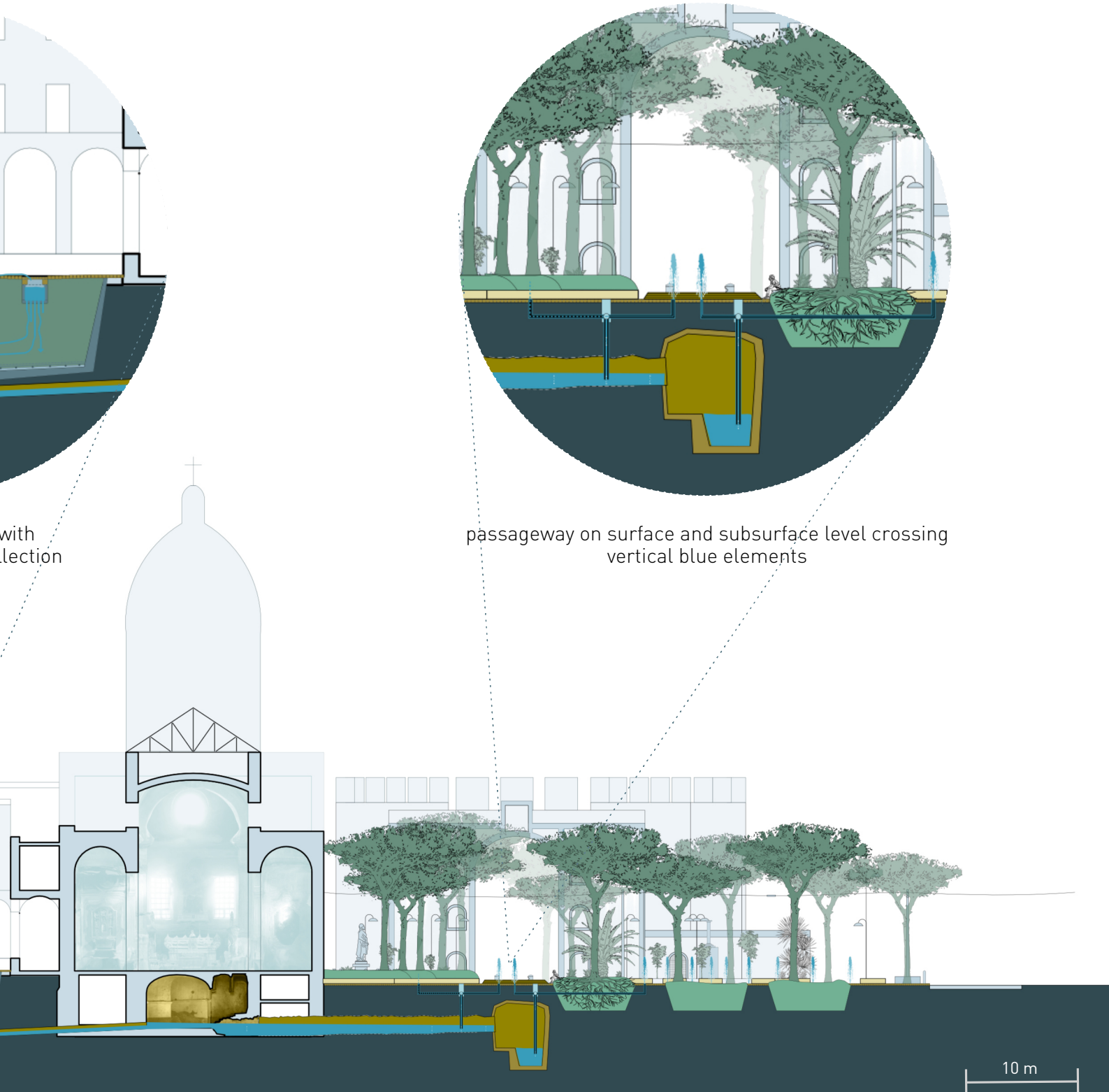


Fig. 97 Section AA'

Green Layer

On vegetation layer, the vertical water will create wetter conditions for the surface soil and enable steady plant growth and maintenance. The recovery of the former green structures of giant Italian stone pine trees and *Gleditsia* that have been cut down in 2018, will be possible through providing a water infrastructure. By establishing an agile shape of the branches and light shadow of the pine trees, an airy and breathing atmosphere of the square will be reconstructed. Next to the mist, the trees will also accentuate the entrance gate by providing a softscape wrapping around the strong form of the fortification (fig. 96; 100). Furthermore, seating elements made out of tuff stone will work like a sponge due to its porous features and through being exposed to water, seeds coming from birds and wind, small micro-flora and fauna will find space in its pores.



The reconstruction of the former cloister gardens (fig.97) in the backyard will create a calm and lush space. While in ancient times, these types of gardens were focussing on food production and pharmaceutical activities, this time they will incorporate more the cooling function, mental wellbeing, intimacy and soft shading through the integration of tree species with translucent canopies, for example *Citrus myrtifolia*, also known as “chinotto” and *Gleditsia*.

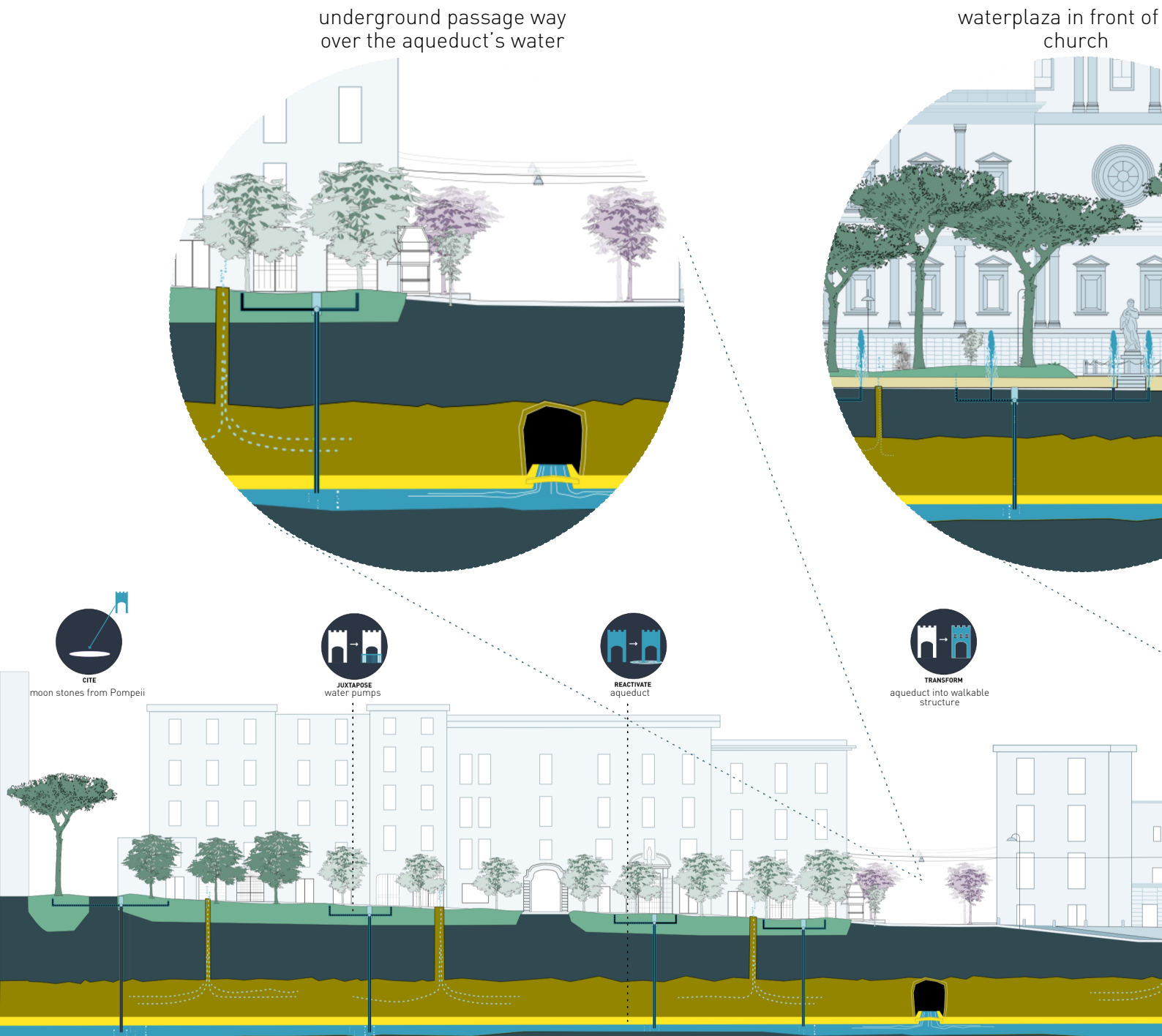
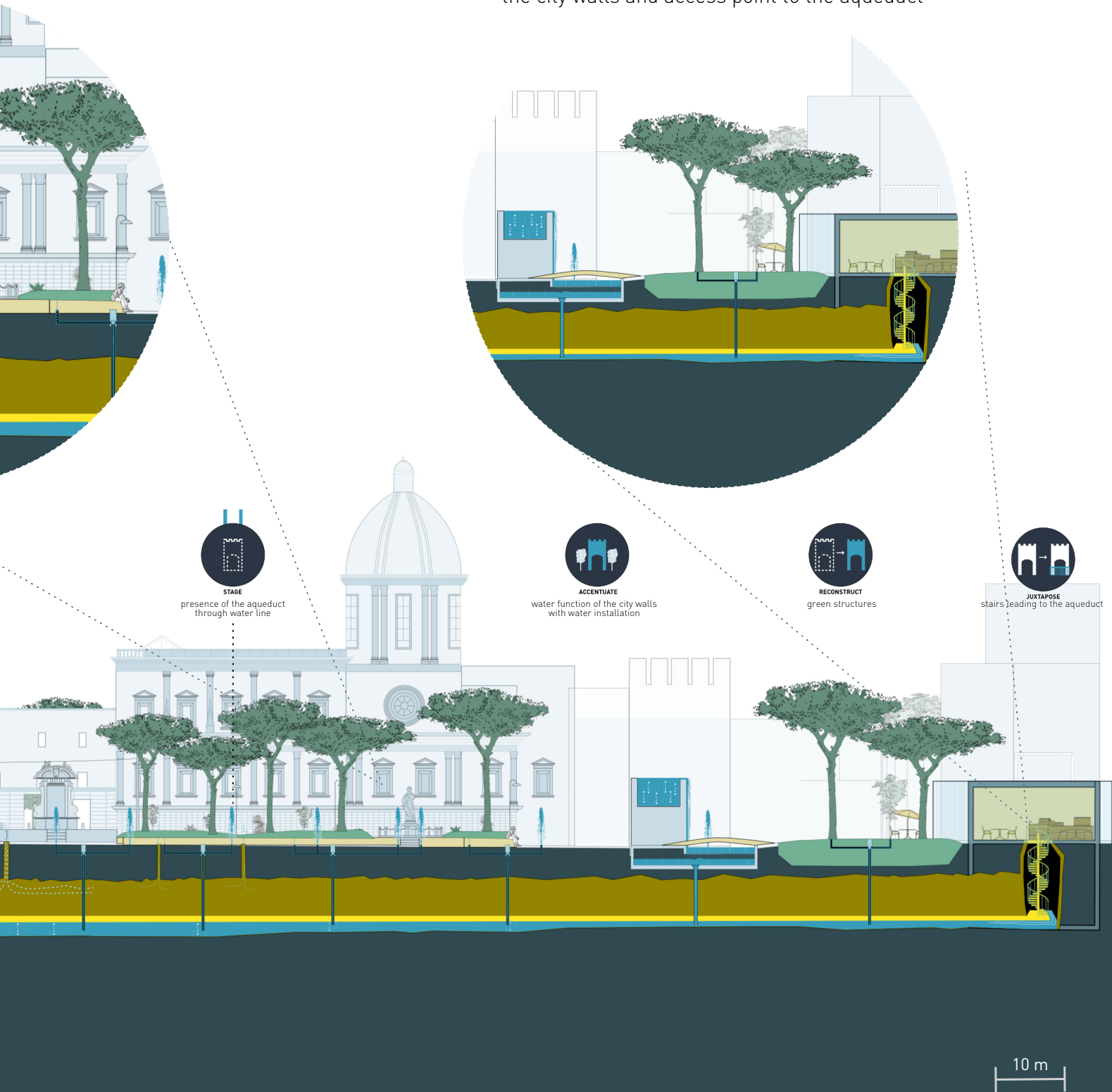


Fig. 98 Section BB'

The trees along the aqueducts line (fig. 98) will represent its presence within the threshold of entrance gate to the city center, before letting the water pipes, air and reflective stones take over when entering the darker and narrow streets of Naples' core.

the

entrance situation honouring the former streams along the city walls and access point to the aqueduct





main water
collection cistern

Via Carbonara

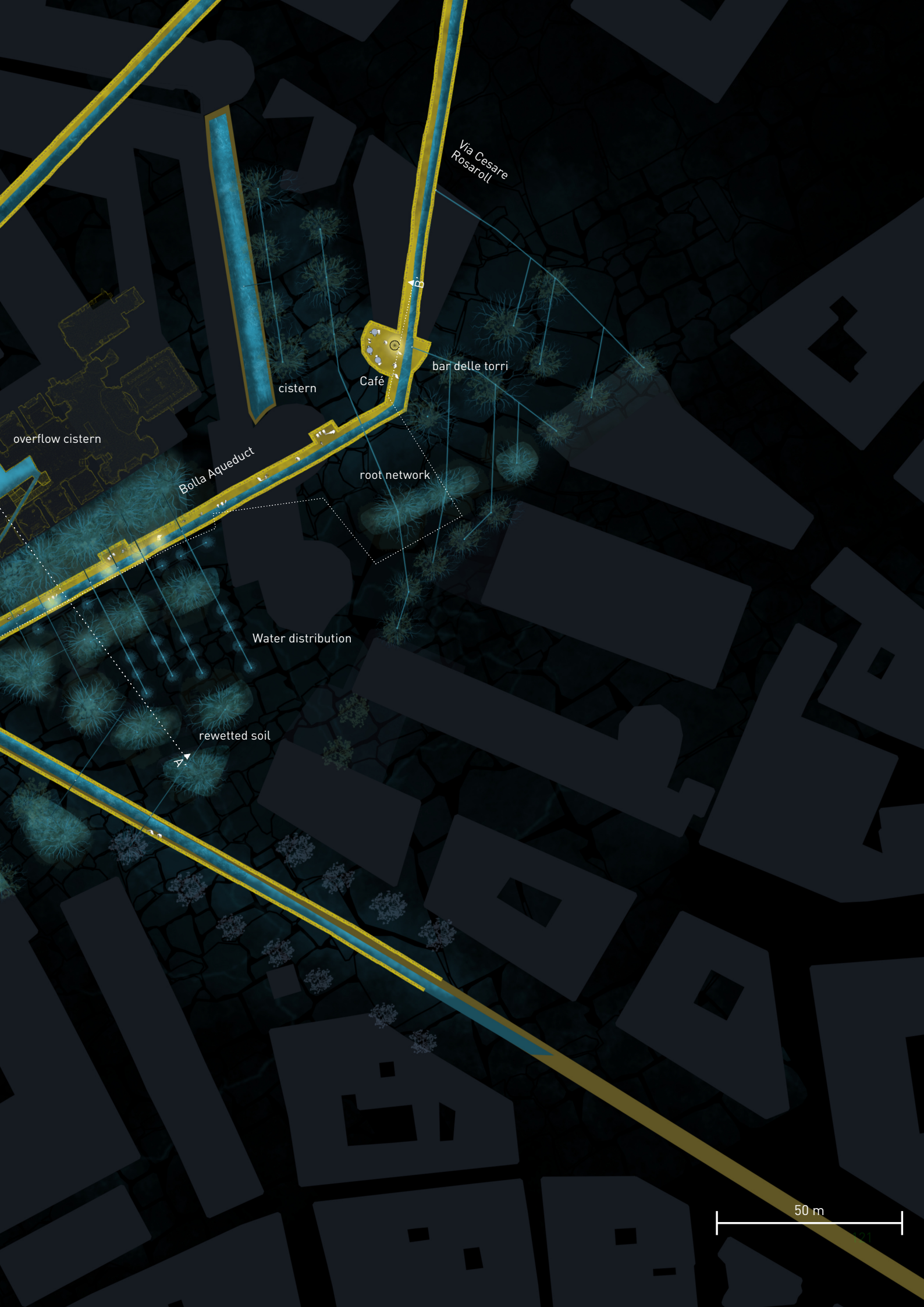
tuff stone soil

walkway

bridges

subterranean water plaza

Fig. 99 Masterplan Porta Capuana - Subsurface



Via Cesare
Rosaroli

bar delle torri

Café

cistern

Bolla Aqueduct

root network

Water distribution

rewetted soil

overflow cistern

50 m

Social Layer

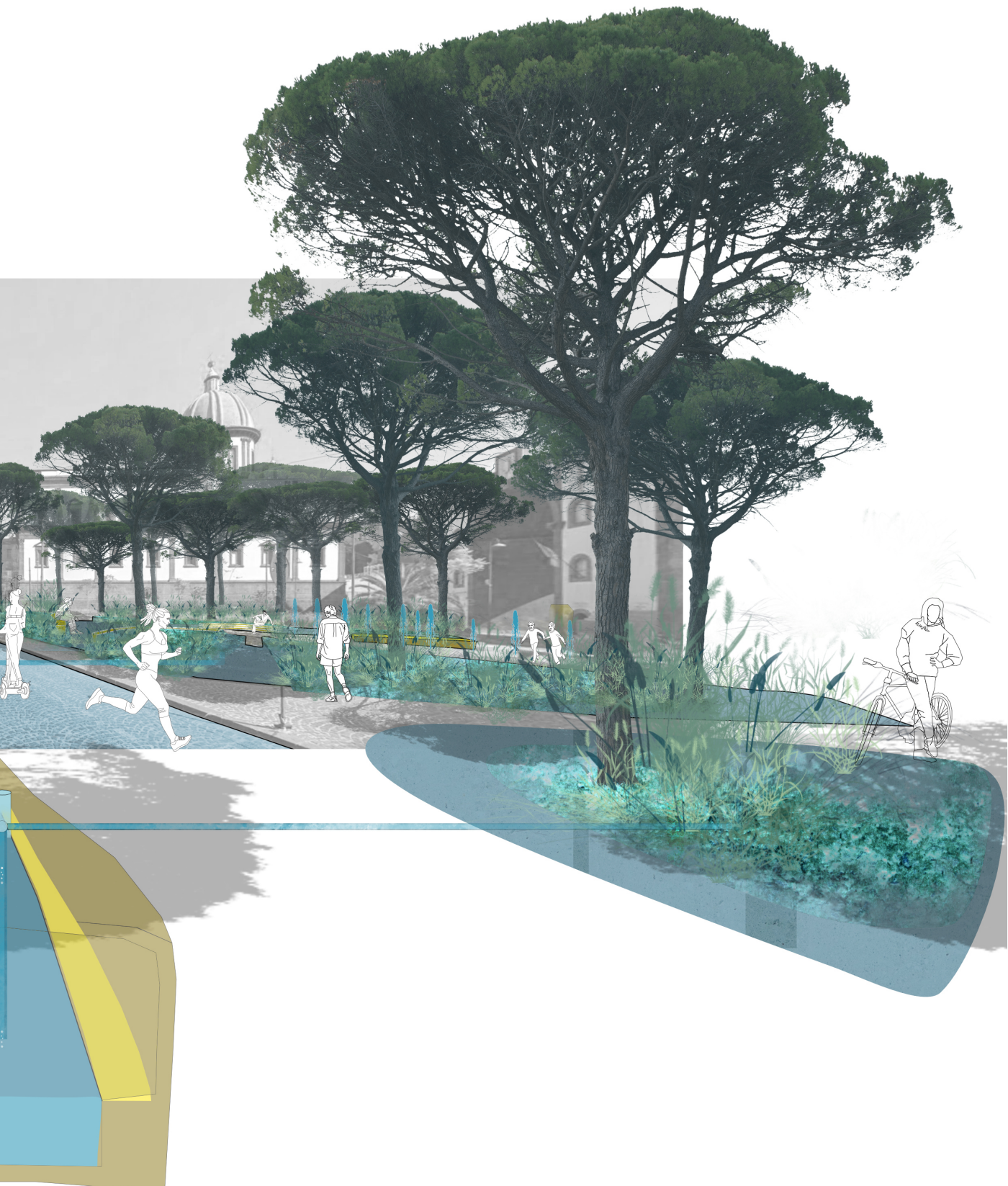
The water elements (fig. 100, 101, 103) create infinite, usable edges within the square and activates the spaces atmospherically and acoustically. The water as a liquid, fluid element has no square meters or edges, and therefore belongs to everyone. Other than that, the water elements are a playful and continuous feature that guarantees to cool down during a hot day and calms down the noise of the city. Seating elements made out of tuff stone will provide space to gather and come together. The courtyard of the wool factory is a calm counterpart to the urban square that incorporates the urban life from all sides. The square but also the courtyard extend the liveable space of the inhabitants' houses into the public space. It becomes their open space, their living room, garden and meeting point at the same time. In addition, by



Fig. 100 Walking from the central train station to Porta Capuana

having the possibility to enter the coolness and welcoming atmosphere of the subterranean spaces, a refuge and shelter from the busyness of the streets is being provided. In the transition zone to the mass-tourism of the city center, this square not only provides a prelude to the city core but also distributes the pressure of people entering the city by guiding them not only on the surface but also leading them beneath it.

This square is the beginning of a sequence of spaces, of the landscape infrastructure incorporating above and below ground features that can be walked through on both levels of the city. The spatial sequences within the infrastructure create binding nodes along its line of public spaces that represent the water heritage and identity of the city, that will be brought back to the Neapolitan life.



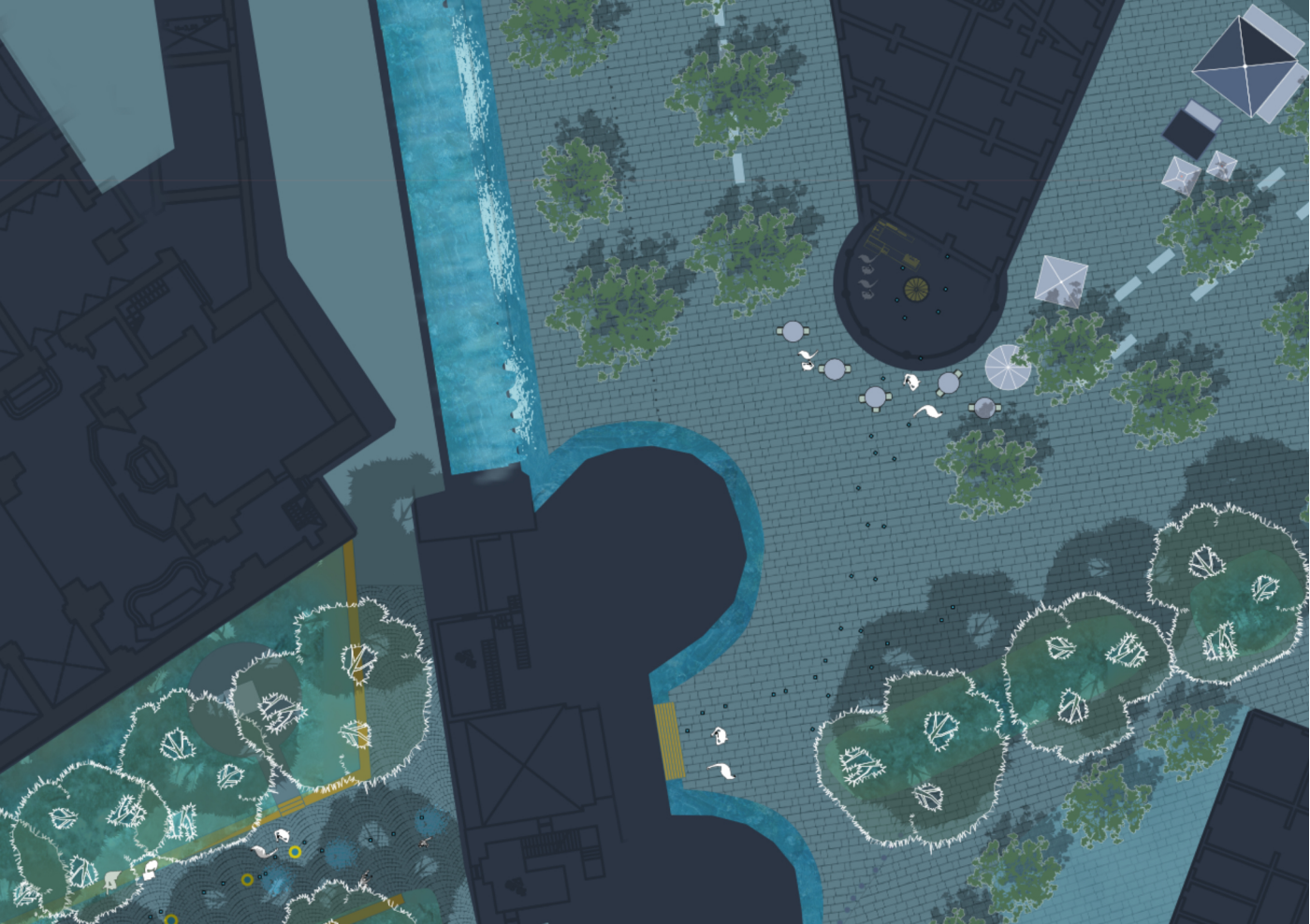
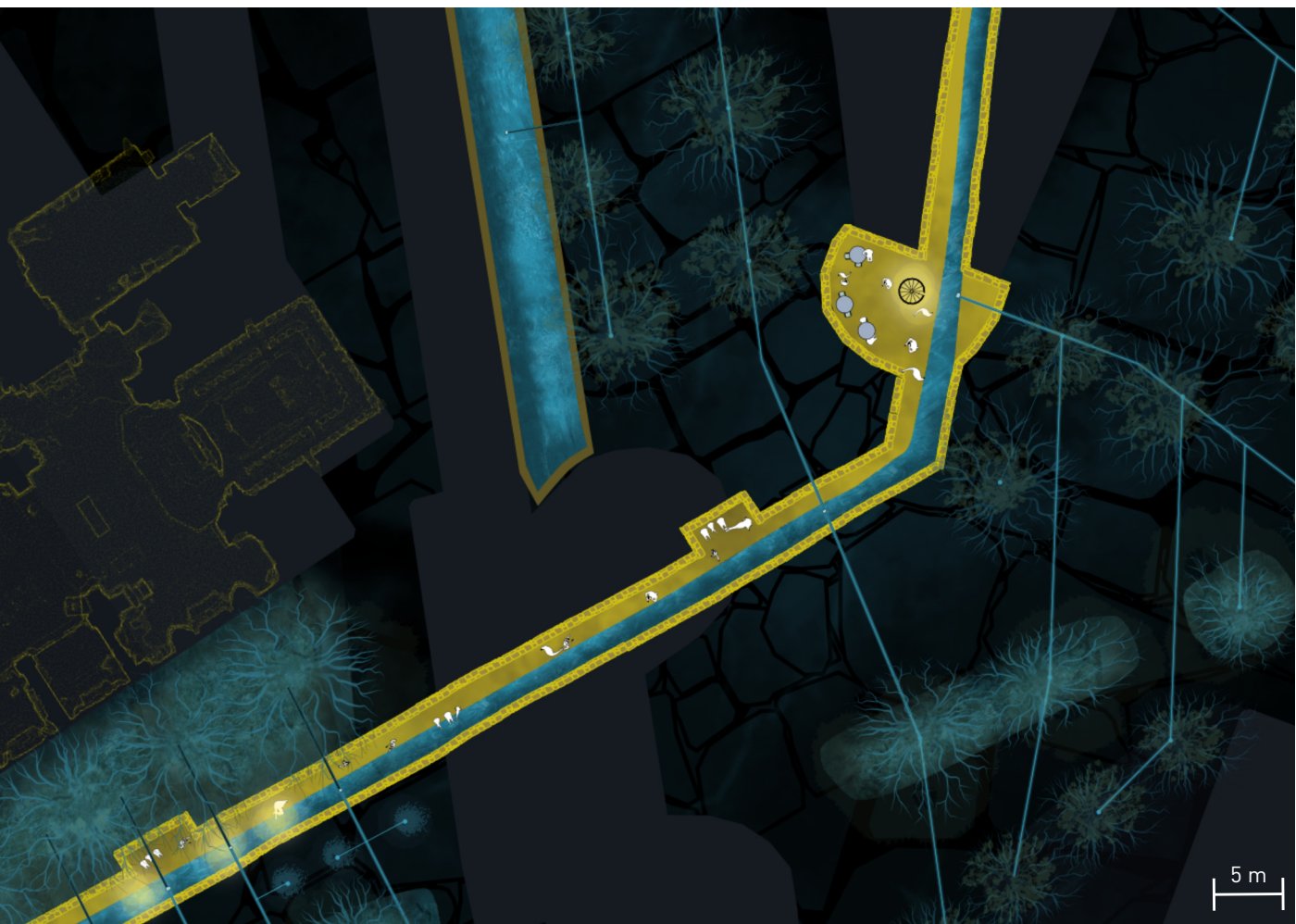


Fig. 101 Water accentuation at the entrance gate and water threshold that can be crossed via a bridge



Fig. 102 Subterranean café with walkway along the water with niches for more intimate meeting and resting points



8.4 A day in the life of a Neapolitan Family

Imagine walking through the city on a summer afternoon. The air shimmers above the stones of the city, and yet, around Porta Capuana, the heat is less oppressive. A soft breeze moves through the square, brushing past the tall pine trees that frame the site. Their wide canopies filter the light and cast long patches of shade on the ground below. The sound of water adds to the rhythm of the place. It flows through narrow channels carved into the paving, gathers in shallow basins, and trickles near shaded benches. Around the square, people move more slowly, but without discomfort. Children chase each other through the mist rising gently near the trees, while older people sit just outside the gate, passively spectating, catching the air that drifts up from the air shafts connected to the world below. A lush, green passageway next to the Church Santa Caterina a Formiello draws residents into their courtyard of the former wool factory, not as tourists, but as part of daily life. There, birds plunge in the fountains basins while others read in the shadow of the buildings and lush vegetation.

*At the edge of the square, near a round shaped building, a woman waits with her youngest child, watching the rest of the family playing in the square. She lives in a *vasci* nearby, a ground-floor space once too dark, busy and narrow to enjoy in summer. Her partner and two older children approach her now from the other side, walking across the shaded plaza and heading for the stone stairwell in the same round shaped building. She chooses the lift, as she is already familiar with the quiet coolness it offers. Stepping inside feels like entering a cool supermarket on a hot day, but gentler. The light is soft, and the stone holds a calm, even temperature. Her coffee stays warm in her hand, as warm as the colours of the yellow tuff stone of the underground spaces.*

Beneath the surface, the atmosphere changes. The underground corridor is quiet, but not silent. From time to time, a voice echoes lightly, or a breeze moves through an air shaft. Vertical openings in the ceiling allow daylight to fall in patches, shaped by the movement of clouds and the rhythm of the square above. These openings also let in the sounds of the city, shoes tapping across stone, distant laughter, the murmur of people gathering near the fountains. The ancient channels, once used to transport water across the city, now additionally carry air, sound, and shade. Along the walls, they hear the water bubbling beneath their feet, going into the same direction. People read, pause, or continue on. A small coffee point with pillowed sitting benches carved into the tuff stone blends into the space, offering a break without interruption, playing soft music.

*The family continues through the tunnel. The pace is slow, the air steady. As they walk, they begin to hear new voices rising from ahead. They reach a stairwell and climb out into Piazza Girolamini, the only bigger open space around their one-room apartment. The space feels both new and familiar. Tall trees mark the edges, water flows quietly through curved basins, and light moves across the surfaces. The ground is warm but never hot, and the breeze follows them still. The woman looks across the square as her children begin to talk with two others they met along the way. She no longer dreams of leaving her apartment. The *vasci* may still be small, but the city outside has changed. The public space has become part of her daily life, a second living room and garden where air moves, water cools, and time is shared.*

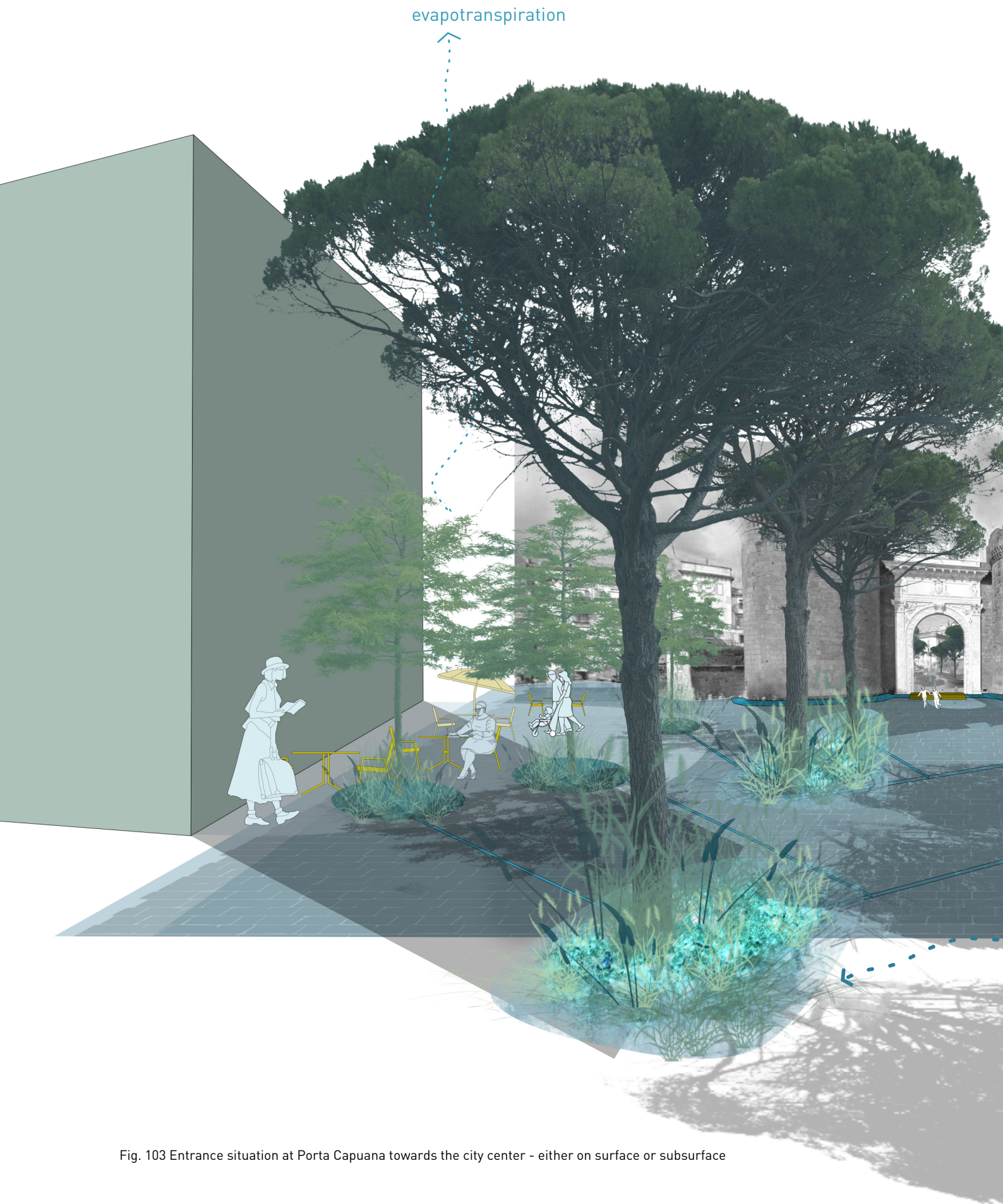
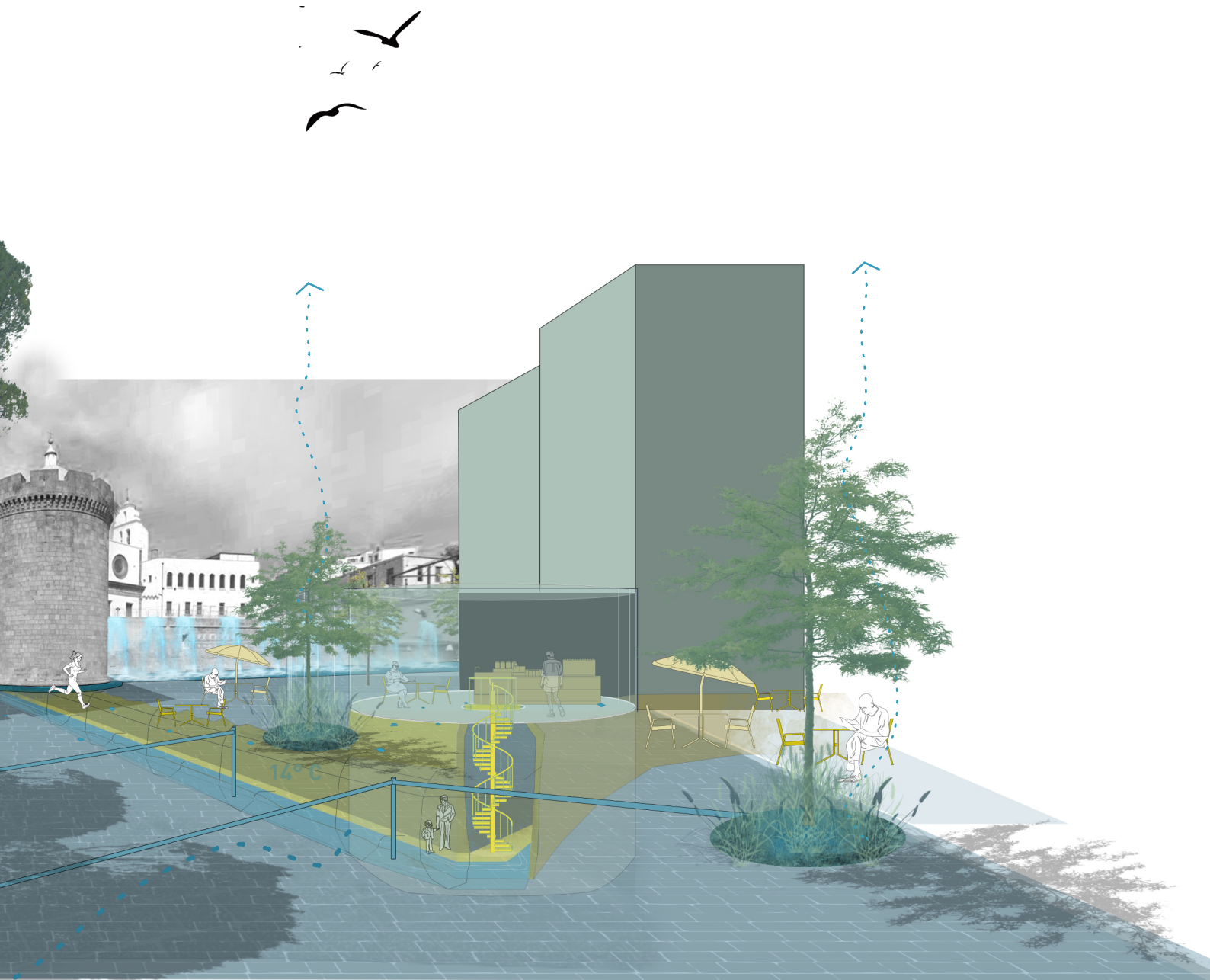


Fig. 103 Entrance situation at Porta Capuana towards the city center - either on surface or subsurface



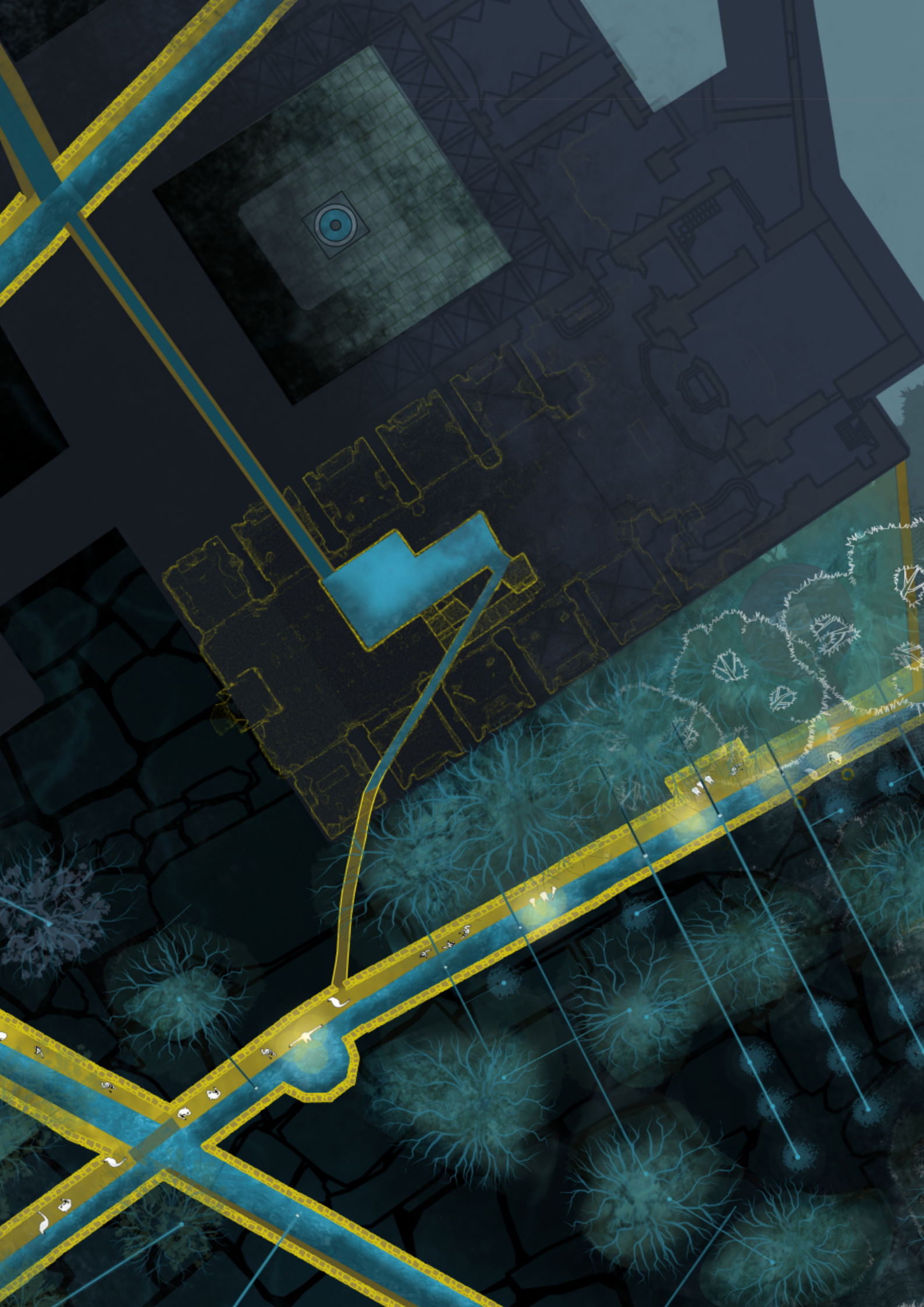
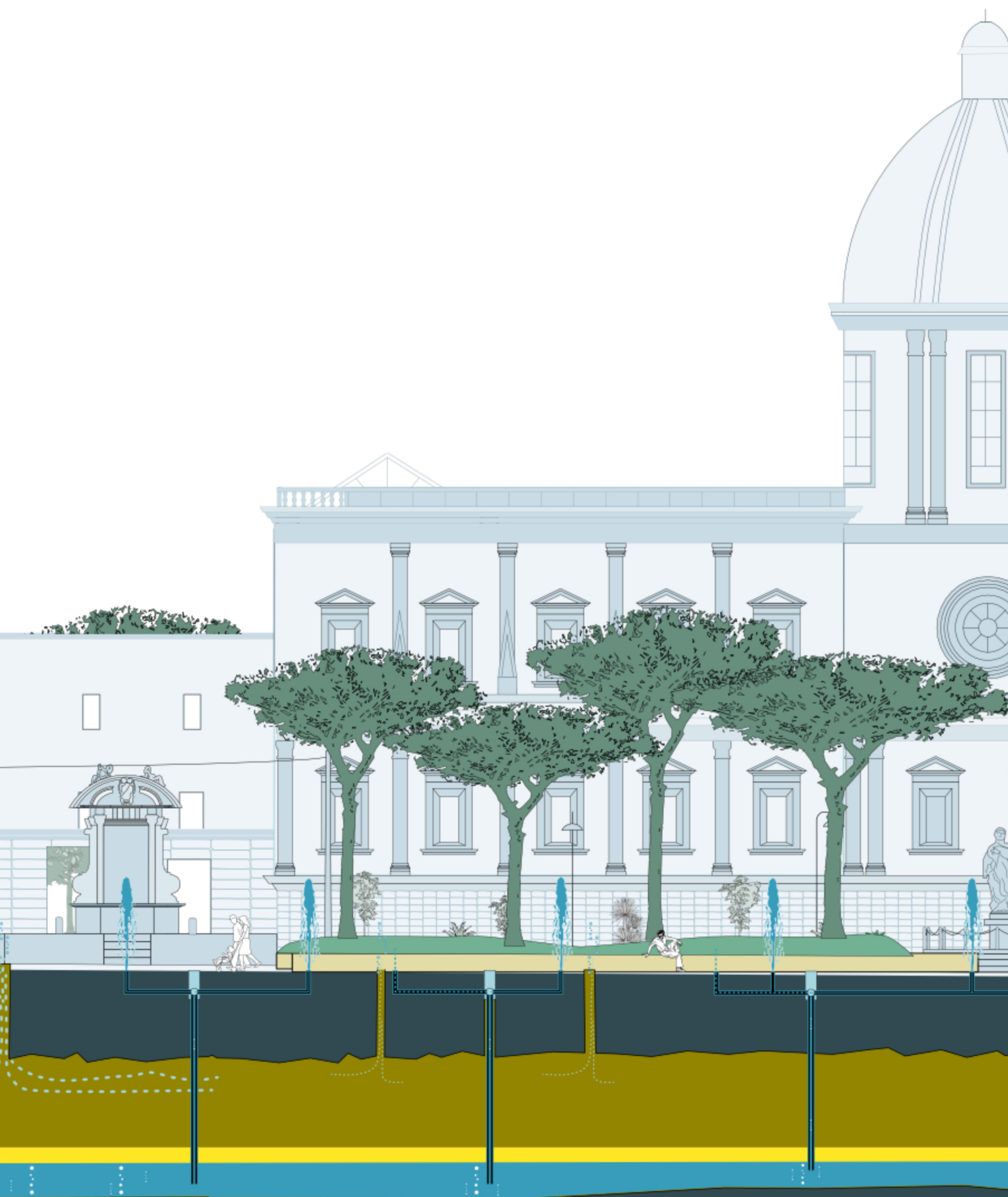




Fig. 104 Duality of both surface and subterranean level

5 m



5 m

8.5 Implementation Perspective

The implementation of landscape-based design in Naples does not only rely on spatial and conceptual clarity but also on a realistic understanding of planning processes, institutional barriers and civic actors. As Prof. Federica Palestino pointed out, Naples still operates under an outdated regulatory framework and the most recent urban plan dates back to 2004, using data from the 1990s. This temporal gap has created a disconnection between planning instruments and current urban dynamics (Palestino, 2024). At the same time, water governance in Naples remains politically sensitive and fragmented, with multiple public bodies involved and limited inter-agency coordination. These conditions pose limitations for systemic or top-down transformation. However, they also create space for more situated, community-driven initiatives. A waterboard with many local actors, similar to the model of the Netherlands, could be created.

The interviews with LAN/CoolCity confirm that large parts of the subterranean aqueduct are still present and, in many cases, still hydrologically connected to the city. Yet the knowledge about these infrastructures is often informal or distributed among small-scale actors such as speleological associations or cultural collectives. As Valentino observed, “we found that all the water used before the Serino aqueduct was now simply being lost – diverted into sewers or pumped into the sea” (Valentino & Devriet, 2024). Their work shows that not only material traces remain, but also an active cultural infrastructure that could be engaged to support implementation. Visualising the presence of this water system and linking it to public cooling, civic rituals or urban learning could help to anchor the design in real-world priorities.

For such a strategy to be implemented, multiple actors would have to be involved. The Comune di Napoli, local environmental agencies and the Soprintendenza for heritage protection, including UNESCO, must be part of the approval process. Public utilities could support technical maintenance, while funding might be secured through European urban resilience programs, climate adaptation calls or cultural heritage programmes. Even small pilot interventions that are being co-developed with residents or schools, could begin to open up the wells and cisterns, establishing visible connection, establishing the water history within the younger generations and for long-term regeneration. Rather than depending on a singular policy shift, the proposal builds on layered implementation: cultural engagement, spatial activation and institutional negotiation. Together, these could make the reactivation of the Naples aqueduct not only possible, but also desirable.

CHAPTER V

DISCUSSION AND CONCLUSION

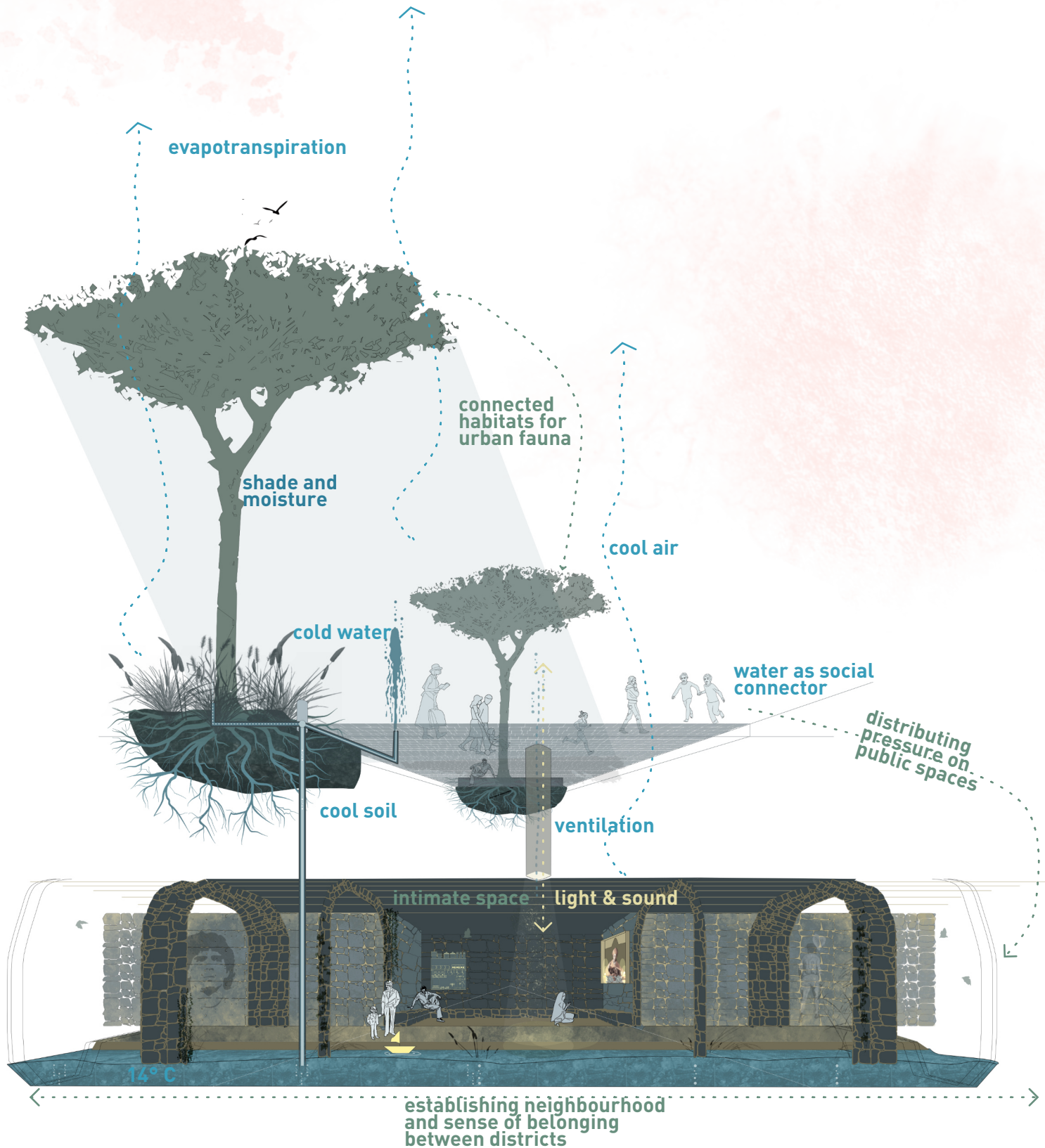


Turning back

Reflecting on the process of being fascinated by the layeredness of Naples and taking water as the guiding and logic line of understanding allowed for a spatial reading of the city that revealed connections between surface and subterranean systems. By approaching the landscape as a base, composed of natural and constructed elements, it became possible to formulate a design approach that responds to social, ecological and climatic questions.

The translation of research into design, including spatial concepts and proposals, made the work tangible. The next chapter discusses the research objective, identifies learnings and limitations, and closes with a reflection on the process and outcomes of the past year.

Breaking up the Urban Heat Island



9.1 Findings

This thesis explored how the subterranean water system of Naples can be reimagined as a landscape infrastructure to support socio-ecologically inclusive and climate-adaptive public space structures, both on surface and subterranean level. By investigating the historical water systems, like the Bolla and Carmignano aqueducts, it became clear that these infrastructural layers are the structuring logic within the chaos of the subterranean, highly connected structures. They are in fact not relics of the past, but the logical spatial structure that creates the multi-dimensional backbone of the landscape infrastructure. The depth, scale, and continuity suggest untapped spatial and climatic potential, particularly in relation to Naples' dense surface conditions and the socio-spatial vulnerabilities of ground-floor inhabitants and lack of non-commercial public space (Esposito, 2023; Gerundo, Di Pinto & De Stefano, 2015). By designing a landscape infrastructure across different spatial layers, a "breathing" city was created that circulates cool air and water between the underground and surface and gives space for the implementation and recovery of green infrastructure and social connection.

Looking back, subterranean water systems turned out to not only provide cool water to the city but also when kept dry, become a provider of cool air and adds another dimension of usable public space to the city. Looking at urban development through the lens of vertical structures creates a methodological approach also for other heritage cities worldwide that are challenged with spatial constraints, conservation and socio-climatic pressures. When looking at the aqueducts as part of the subterranean cavities landscape, they provided a logical spatial order in the chaos and layeredness of the underground spaces. The water infrastructure mostly runs parallel to the public spaces above and therefore gave important hints for where to place surface-level interventions when trying to create designed links between both worlds.

The mapping of public space typologies and surface-subterranean relationships highlighted that the current public space structures do not absorb heat or social tension effectively, but could, if connected to the subterranean hydro-logical landscape. In addition, the subterranean world in Naples is not officially mentioned in the UNESCO heritage listing, meaning that there is potential for landscape-based urban development but also for simultaneously creating a valuable and protected subterranean heritage site in a future-proof state.

Case studies revealed transferable principles: water as a spatial connector, architectural element, underground excavations as climate shelter, and the atmospheric potential of cool, humid cavities with a physical connection to the surface. These informed a design strategy that translates traditional linear water infrastructure into a vertical, multifunctional network that operates across climatic, ecological and social dimensions. It not only focuses on the transportation of water but also on cooling air and people. The resulting proposal is not only spatially layered but also rooted in time as it represents the city's history while creating future-proof public space structures. While the realization of such a system requires institutional support and long-term maintenance, the design exploration in this thesis demonstrates how Naples' underground water infrastructure can serve as a spatial and symbolic medium for regenerating everyday life and continuing to write the history of the city's foundational elements.

Learnings and limitations

The design process brought several important observations that helped shaping the direction of the project. Throughout this process, it became clear that landscape in Naples cannot be defined only by green areas or surface interventions. Instead, the project sees landscape as a system of water, air, thresholds and underground space that incorporates elements that shape how the city is experienced and how it could change in the future. These spaces offer more than just reuse potential. They offer a different way of thinking about design, one that starts with what already exists below.

Furthermore, the initial understanding of the water system in Naples itself as a classic, water-fed blue infrastructure, changed throughout the research, fieldwork and interviews with experts on site. The idea of vertical blue as water-only infrastructure turned into an understanding of blue representing coolness, air, humidity and water narratives.

A further insight was that the underground water system in Naples does not have enough pressure to bring water back to the surface by itself. A model like the skundo system in Tetouan, which relies on gravity and water pressure, was therefore not possible in this context. This required a different approach for reconnecting underground water to surface life by using pumping systems.

Moreover, the use of photogrammetry to document underground spaces worked well in dry areas but stopped where water filled the tunnels and blocked access. Still, during fieldwork it became clear that the network of aqueducts and excavations is more complex and connected than current maps suggest and also runs water in many of its parts (Gentilcore, 2019; LAN/CoolCity, 2024).

These underground spaces are not only part of Naples' history as they also influence temperature and climate conditions. Many of them are cool, damp and shaded, and could help improve comfort in parts of the city where outdoor public space is often overheated and sealed off (Zhang, Nijhuis & Newton, 2022). However, it is still difficult to measure the ecological impact of these underground spaces. In some places, passages were blocked with debris from the Second World War or closed off in more recent decades (Gentilcore, 2019). Many of these spaces are not shown in planning documents and are also not part of UNESCO's official heritage list, even though they hold environmental and cultural value.

Additionally, as much as it is important to have access to drinking water, the location of Naples with all its climatic, social and ecological factors proves that clean but non-potable water is still another resource of life, for cooling purposes and health, social interaction and ecological improvement.

In addition, the exact position and condition of the aqueduct channels, the spatial dimensions and accessibility of the cavities was derived from a limited amount of archival, written and oral resources and would benefit from further investigation and setup of a digital and GIS-based database of these spaces.

While the design proposal is supported by spatial, social and experiential analysis, it must be acknowledged that the ecological claims of this thesis would benefit from technical simulations and performance-based evaluations. The project was developed within a limited timeframe, which restricted the implementation of microclimate modelling, thermal comfort analysis or hydrological simulations. As a result, the ecological potential of subterranean cooling, air humidity, and thermal regulation remains largely conceptual. Future research should investigate these atmospheric phenomena more deeply to validate and refine the climatic benefits proposed in the design.

Consequently, this combination is an attempt to break up the urban heat island (UHI) into smaller units or even mitigates the UHI effect. Further climate assessment needs to be investigated in order to find out if these small-scale interventions have a noticeable impact or if interventions on a bigger scale are needed.

9.2 Conclusion

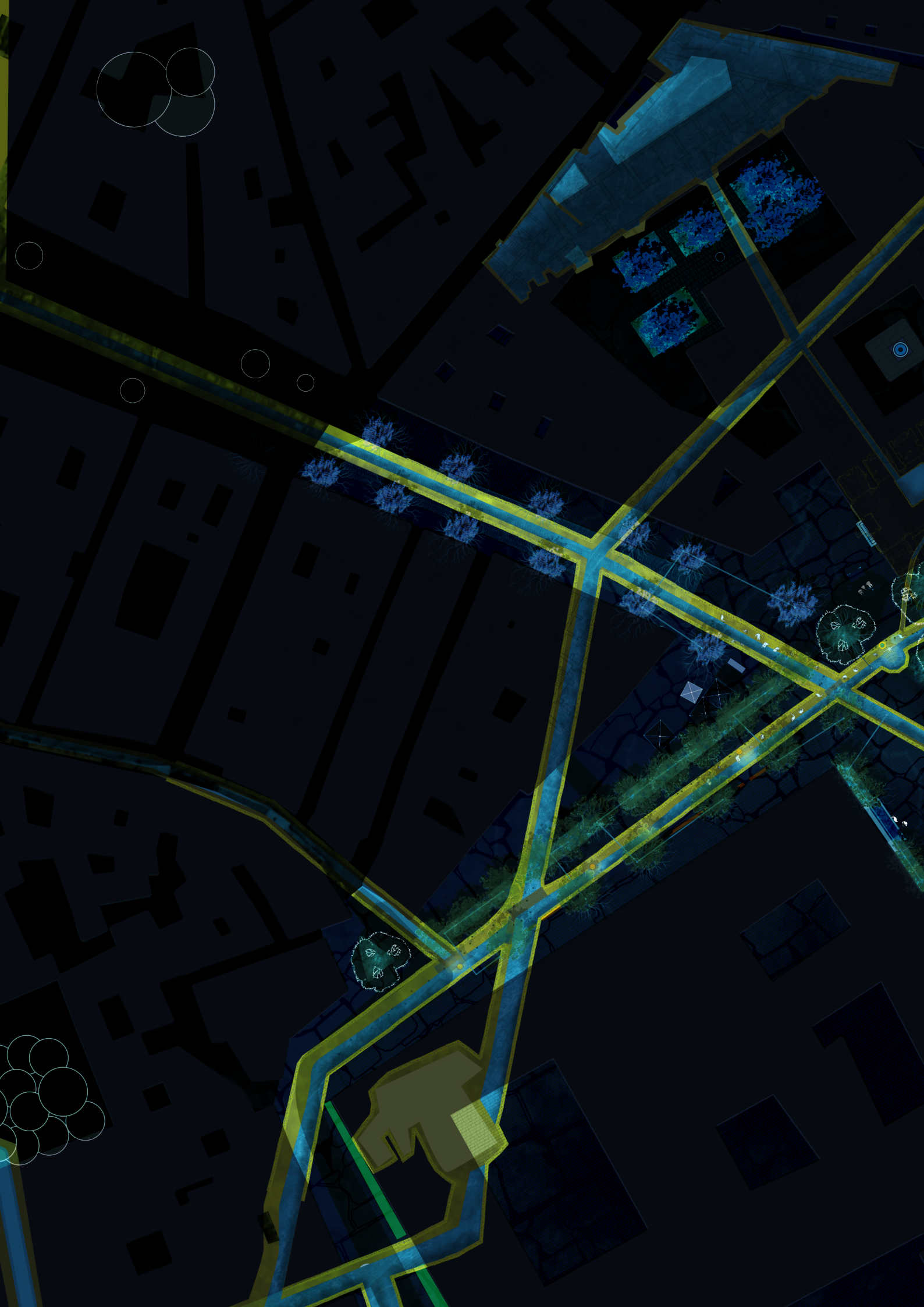
The research objective of this thesis was to explore how the subterranean water system of Naples could be utilized as a landscape infrastructure to foster socio-ecologically inclusive and climate-adaptive public spaces. The investigations revealed that the hidden water systems, once central to the urban and social life of Naples, still hold an extraordinary capacity to structure and revitalize the city of today. By recognizing the aqueducts, wells, cisterns and tuff stone excavations as spatial features rather than as forgotten technical relics, it becomes possible to integrate them into a future-oriented public space network.

The thesis began with a clear observation: Naples's historic center is unable to meet the socio-ecological and climatic needs of its residents. Public spaces are fragmented and often reserved for tourism, while locals live in spatially and climatically challenging conditions. Especially those in precarious housing types such as *bassi* face the absence of livable public space just outside their front door. At the same time, the city's dense and heritage-protected nature leaves little room for green infrastructure. By identifying the subterranean water system as an underused but spatially rich layer, the design opportunities responded directly to the challenges. Water was taken as a structuring and logic landscape element to enable a reconfiguration of public space: vertically rather than horizontally, accupunctually rather than disruptively. The landscape-based approach made it possible to formulate small-scale, accessible interventions based on a landscape system that bring social, ecological and climatic value without requiring much surface area. By addressing the city's built materiality and complex social realities, the project proposed inclusive spatial improvements that address unacknowledged structures beneath the city. Through the lens of water, and supported by the concept of landscape infrastructure that helped identifying all the elements part of the water infrastructure, the challenges of heat, socio-ecological fragmentation, social exclusion and lack of public space were met with a layered, adaptive and landscape-based strategy. The result is not a singular fix, but a coherent system of interventions that match the complexity of the city itself while staying open to flexible use.

Utilizing the subterranean water infrastructure involves reactivating its physical presence as well as restoring its cultural and ecological meaning. Water is introduced as a connective medium between the underground and the surface, makes both the surface and subterranean world equally important and dependent on each other. Through the design of vertical connections, the coolness, humidity and symbolic narratives stored underground are brought back into the experience of daily life. Public spaces become active interfaces, where water presence, air flows and green structures cooperate to regenerate environmental quality, cultural value and social use.

Therefore, the reactivation of Naples' subterranean infrastructure is not only about recovering historical layers, but about transforming them into a living, breathing part of the city. The subterranean water network becomes the backbone of a landscape infrastructure system that embraces the complexity, the depth and the heritage of Naples, while addressing urgent climatic and social challenges.

This thesis researched how the subterranean water-system of Naples works and how it is connected to the city's public space structure. The subterranean water system of Naples consists of a dense mesh of aqueducts, cisterns, wells, and cavities, primarily constructed from and within the city's porous tuff stone subsoil (Gerundo, Di Pinto, & De Stefano, 2015). The Bolla and Carmignano aqueducts, developed from ancient times through the early modern period, created a layered infrastructure of water provision, often accessed via wells directly in public courtyards, plazas, and streets (Gentilcore, 2019). While much of this infrastructure lies inactive today, its spatial logic still underpins the city's morphology. In areas like Porta Capuana, Piazza San Gaetano and Piazza del Plebiscito, remnants of these systems remain embedded beneath and around key public spaces, though no longer visible or functional. The surface-subsurface disconnection has led to the abandonment of these systems as a public resource, despite their potential to fight urban heat, provide humidity, and structurally reconnect fragmented open space networks.



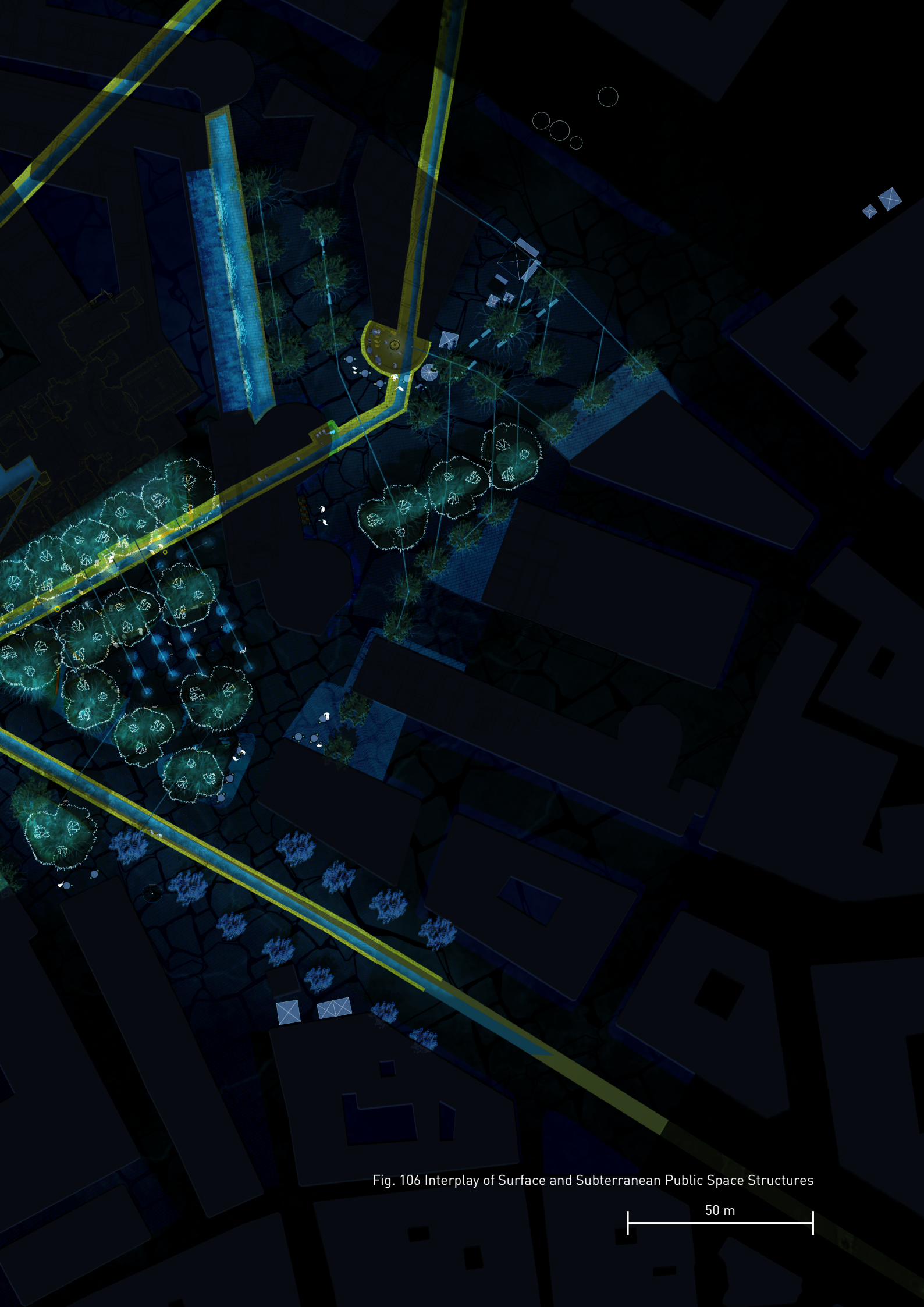


Fig. 106 Interplay of Surface and Subterranean Public Space Structures

50 m



Fig. 107 Interaction of Blue and Green create social and ecological conditions

1 m

9.3 Transferability of the work

Existing strategies across various global case studies suggest that subterranean water infrastructure can be reactivated through three main design principles: visibility (making water and voids perceptible), accessibility (offering physical entry points), and multifunctionality (linking water with public, ecological, or cultural uses). In Istanbul and Derinkuyu, subterranean voids have been adapted into civic or ritual spaces, often with architectural expressions at the surface. In Naples itself, initiatives like Napoli Sotterranea demonstrate that underground cavities can attract both tourism and community engagement when made legible and safe. However, many of these remain isolated events. As such, the spatial integration of subterranean spaces into the public realm, for example via vertical access, visual hints and climatic perceivability, emerges as a key strategy for transformative activation.

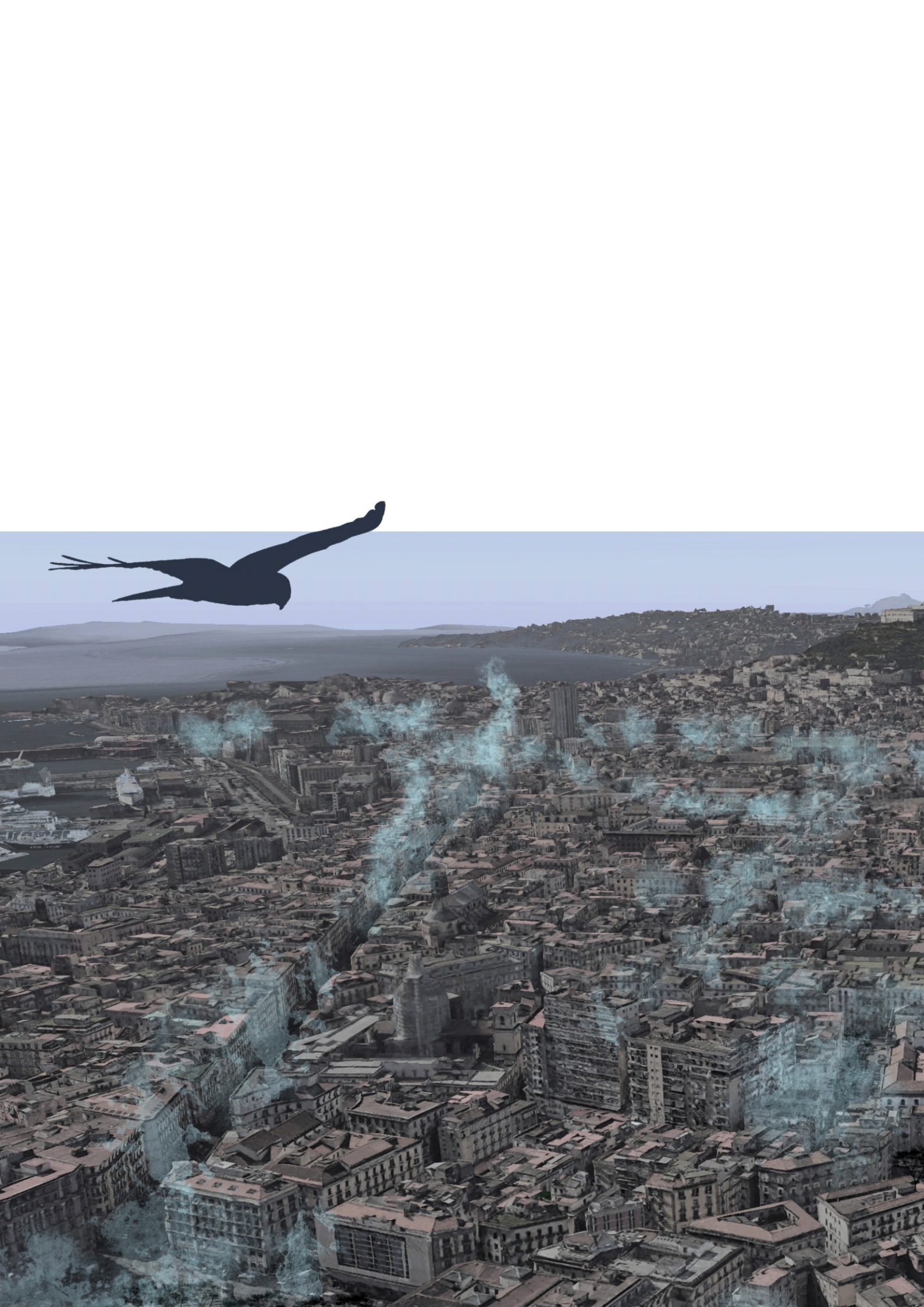
The design of a multi-dimensional landscape infrastructure for the city center of Naples translated the existing horizontal water systems into a vertical landscape infrastructure. The thesis introduced a three-dimensional framework that binds surface and subterranean realms together. This approach extends landscape infrastructure theory from linear multi-purpose corridors to three-dimensional, climate-adaptive systems rooted in cultural heritage landscapes along the line of water.

Although developed for the specific context of Naples, the research approach and design logic may be relevant for other historic cities with similar spatial constraints. Many urban centers under UNESCO protection face the challenge of maintaining cultural continuity while adapting to present-day needs. Often, the underground holds infrastructure that could once again contribute to public life. By working with the vertical dimension, this thesis explores how water can bring value where space is limited. The combination of atmospheric, spatial, and ecological effects found in underground structures offers a way to improve environmental comfort and social presence without altering the surface in disruptive ways. Vertical Blue becomes a method to unlock what already exists and to build with the layers of the city rather than over them.

9.4 Personal Reflection

The main takeaway of this year's thesis work is that finding clarity in the complexity of a design site is an important skill to develop when working with multi-layered sites like Naples. A location so rich in context can easily lead to be overwhelmed, but by taking one particular approach through the lens of the subterranean water system, the structure of the work followed a "blue" line from start to finish. Also the realization of "blue" as more than just water made the design interventions varied and rich in their impact which helped to address the challenges in a meaningful way.

Through this year I had the opportunity to interact with experts guiding my research and design process. By going to Naples and start talking to experts from university to local researchers, I realized that they were not always familiar with each other's work. By introducing them to the fact that within the city of Naples there are many people working towards the same or similar goal for a better city through water, connections could be established. I hope that with this thesis, I could represent the work, especially of CoolCity and Professor Palestino, that tremendously fight for better conditions within the city of Naples from the bottom up. Their efforts, research and collaborations are a good example of how local and non-governmental initiatives can grow and inform research (by design) and eventually get the chance to be heard by municipal authorities to put their ideas into larger meaningful frameworks for urban development.



9.5 Outlook

This thesis has developed a design approach that reconnects the surface and the subsurface through the spatial logic of water system. By focusing on Naples, it worked with the specific conditions of a compact, historic city where classic green structures often no longer find space. The project has shown how the vertical relation between the ground and what lies below can open new directions for public space and climate adaptation. It proposes a landscape that is not added, but uncovered.

Hopefully, this vertical blue approach can be seen as a conceptual framework for other historic cities in the Mediterranean. Many of them face similar pressures of heat, tourism and spatial limits, yet hold buried systems and forgotten layers that still shape daily life. The thesis suggests that the way forward does not always lie in expansion, but in reading deeper.



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10

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10.2 Interviews

Federica Palestino, Associate Professor of Urban Planning at the Department of Architecture, Federico II University, Naples, Italy (2024)

Manuel Orabona, Department of Architecture, Federico II University, Naples, Italy (2024)

Alexander Valentino, LAN, CoolCity, Napoli (2024)

Martin Devriet, LAN, CoolCity, Napoli (2024)

10.3 Documentary

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