from "Stone City" to "Hidden Water Region"

visualize and value the invisible water flows in Matera



from "Stone City"
to "Hidden Water Region"
visualize and value
the invisible water flows in Matera

Wenting Gao
Landscape Architecture
Faculty of Architecture and the Built Environment

June, 2023

Delft University of Technology
This thesis has been produced with the guidance of the

First Mentor
Dr. Ir. Inge Bobbink

Second Mentor
Ir. Francesca Rizzetto

from "Stone City" to "Hidden Water Region"

visualize and value the invisible water flows in Matera

Acknowledgement

This thesis starts with my fascination of water, and gradually developed with my knowledge from the Master study in Landscape Architecture track in the Faculty of Architecture and the Built Environment at Delft University of Technology.

First, I want to thank my main tutor, Dr. Ir. Inge Bobbink, for guidance, critical advices and encouragement during my research of Sassi di Matera and my design project in Matera. I am also extremely grateful to my second mentor, Ir. Francesca Rizzetto, without your rich knowledge of the history, culture and society in southern Italy, it's impossible for me to understand Matera and finally deliver a project for the local people. In addition, I want to express my appreciation to all teachers who have lectured me in TU Delft for their insightful lectures which are of great benefit to me in these two years.

I am also really grateful to all my collogues in CWS lab, for you have gave me your precious suggestions and companions. Finally, many thanks go to my family and my friends for their unfailing love and unwavering support.

01 FASCINATION

1.1 Sassi di Matera: from stone city to hidden water city 9
1.2 Water wisdoms in Sassi di Matera 14

02 INTRODUCTION

2.1 Context of Matera 19
2.2 Major challenges: disconnection between water usages 21
2.3 Major challenges: disconnection between settlements 23
2.4 Major challenges: disconnection between natural areas 27
2.5 Problem statement & Research question 28

03 METHODOLOGY

3.1 Workflow 30
3.2 Theory: Landscape narrative 31
3.3 Theory: Neighbourhood unit & 5-minute walk 33
3.4 Case study: Between the waters 34
3.5 Case study: The brightwater treatment 35

04 DESIGN PROPOSAL

4.1 Matera: from hidden water city to hidden water region 37
4.2 Designing scale: water narrative routing 41
4.3 Drinking water fountain 43
4.4 Grabiglioni 46
4.5 Wastewater treatment plant 52

CONTENT

05 DESIGN ELABORATION

5.1 Representation of water: colour & form 57
5.2 Water circulation 59
5.3 Purification: wastewater park 60
5.4 Reclamation: from traditional to sustainable olive orchard 69
5.5 Reclamation: bio solid park 74

06 CONCLUSION & REFLECTION

Conclusion 79
Reflection 80

REFERENCES



Figure 1.1



Figure 1.2

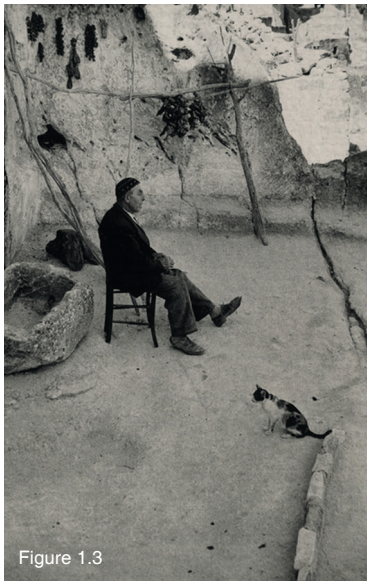


Figure 1.3



Figure 1.4

01 FASCINATION



Figure 1.5



Figure 1.6



Figure 1.7

Figure 1.1, 1.2: Henri Cartier-Bresson Matera, Basilicata, Italy. 1951. © Henri Cartier-Bresson | Magnum Photos
Figure 1.3, 1.4: Dan Weiner, Matera, Italy, Museum Purchase, International Fund for Concerned Photography, 1974
Figure 1.5: https://www.artsy.net/artwork/mario-carbone-matera-i-sassi-1
Figure 1.6: http://www.muvmatera.it/aspFoto/percorsi.asp
Figure 1.7: Henri Cartier-Bresson Matera, Basilicata, Italy. 1951. © Henri Cartier-Bresson | Magnum Photos

1.1 Sassi di Matera:
from stone city to hidden water city



Sassi di Matera is located in the municipality of Matera, Matera province, Basilicata region, southern Italy. And it has become a very famous destination at home and abroad since it was named UNESCO world heritage site in 1993 for its sustainable water harvesting system and outstanding cave dwellings. The Sassi have been defined as a cultural landscape, to quote the definition with which they were welcomed into the UNESCO World Heritage Site. The Sassi of Matera are two districts of Matera, Sasso Caveoso and Sasso Barisano, formed by buildings and rock architectures carved into the rock of the Murgia Matera and inhabited since prehistoric times. Together with the Civita district (built on the spur that separates the two Sassi), they constitute the historic center of the city of Matera.

For most visitors and even the locals, Sassi di Matera


Outer form: stone city
Internal mechanics: hidde



is a stone city with unique architectural style, and this conclusion is simply drawn from its outer form. But from the perspective of a landscape architect, and after deep researches of Sassi, I found its internal mechanics is far more interesting, so it's more authentic to call it a hidden water city.

Because of Sassi's past humiliating history, residents avoid talking about their past life and regard them as painful memories, so the story of the water system is also ignored. On the contrary, the hidden water system showed us the bright side of old Sassi di Matera. It had provided a possibility of sustainable life style in the past days, and had made great contributions to public life and green space in town.

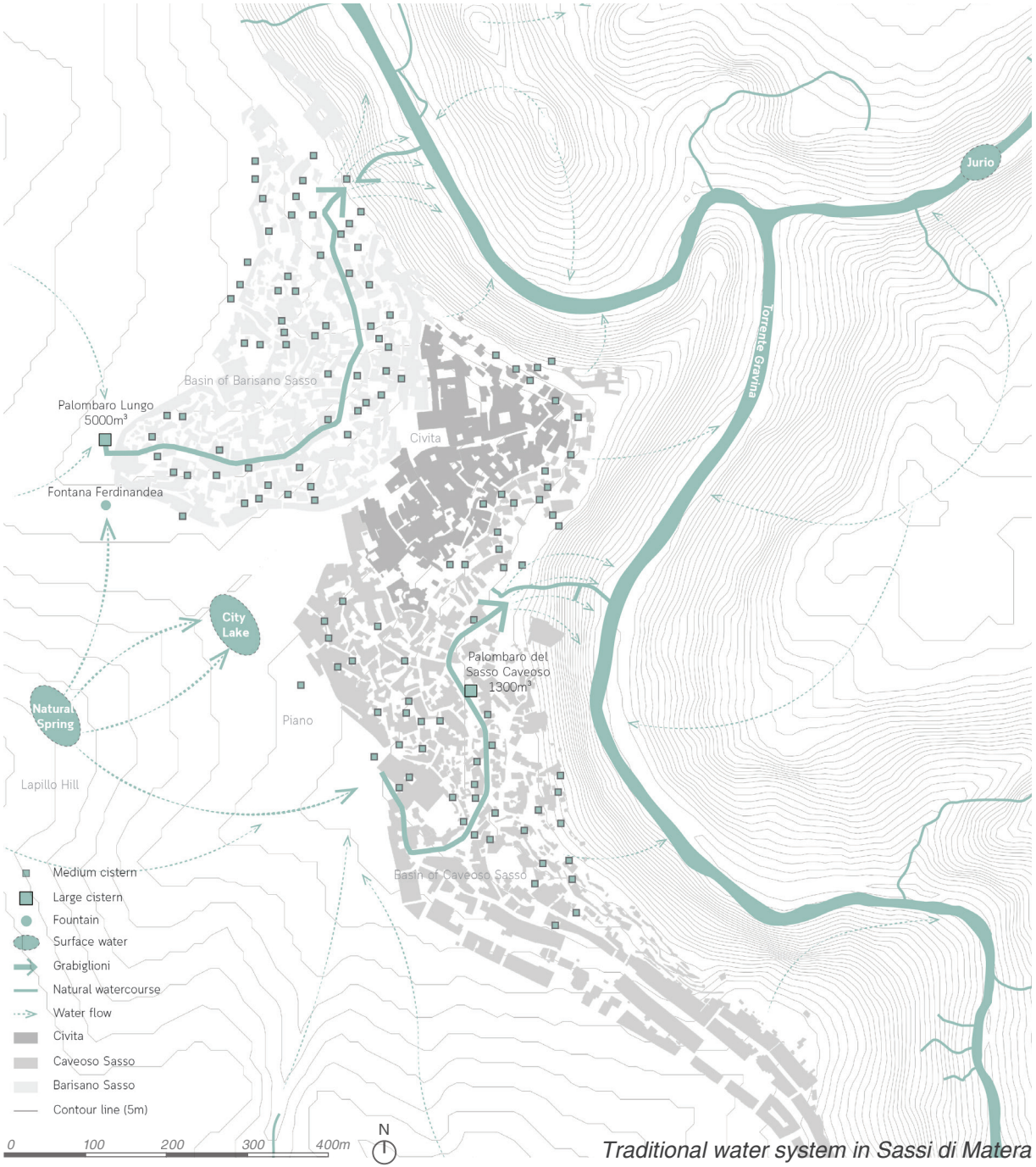
About 2210 cisterns were identified using a statistical approach, including 2039 small bell-shaped cisterns, 170 neighborhood cisterns and two large cisterns of 1,300 and 5,000 m^3 each. Water not only shaped the physical part of the city, but also influenced the way people live and work. The successful water-harvesting system created an agro-pastoral society where most people were engaged in agriculture and husbandry, and about 56% were still land-working peasants in 1754.

Due to low precipitation throughout the year, water was a scarce resource in this area and people cleverly managed to live with water relying on the unique geological and topographical conditions. The first settlements date back to Paleolithic times on the opposite side of Sassi di Matera. In the Neolithic village of Murgia Timone, there is a system of tanks which are dug into the limestone to collect rainwater and get drinking water. The utilitarian ditch with the function of draining the soil and collecting water and manure is also found. Roof cisterns prove the further development of the primitive water works. These water works make it available to passing-by herds and becomes the basis for the transformation from nomadic life style to agro-pastoral society later in Sassi.

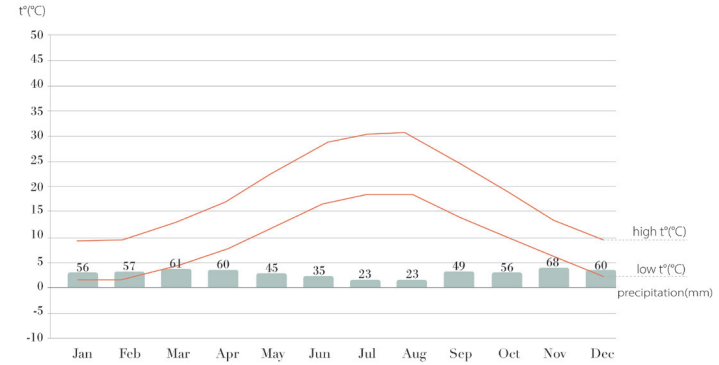
Sassi di Matera is a city shaped by water and rocks. Instead of building directly near water, the Gravina, they had taken full use of the soft rocks (Calcarenite di Gravina, also called tufo) to create caves dwellings, houses, and cisterns to store rainwater for production and domestic use since the Bronze Age.

The section shows the city and the water-harvesting system based on tuff, and there is a close relationship between the water space and public space, e.g. the stairs connecting different heights are not only for people to go up and down, but also for water to flow. Interestingly, wealthy people moved to the f lat plain above the ravine, the piano; and so began a process of hierarchical ordering of space by class. This separation continued over the following centuries and resulted in the emergence of two antithetical worlds, the Sassi and the piano, which did not meet physically or interact socially. Dominating physically and economically, the elite became like spectators at the theater, watching from their windows and balconies as the peasants acted out their lives in the Sassi.

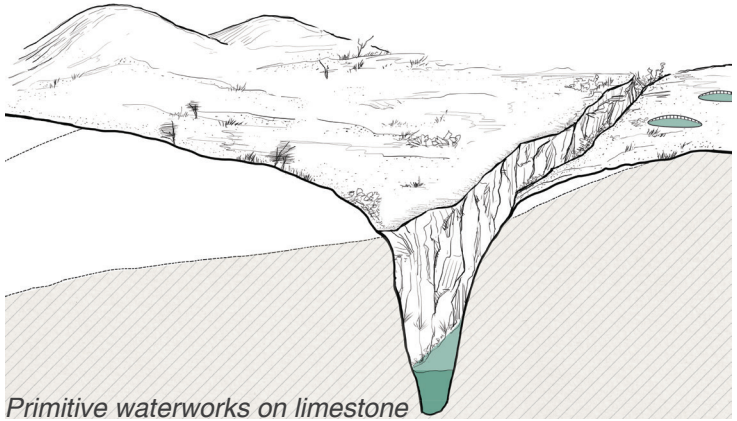
Figure 1.8: https://it.wikivoyage.org/wiki/Parco_della_Murgia_Materana



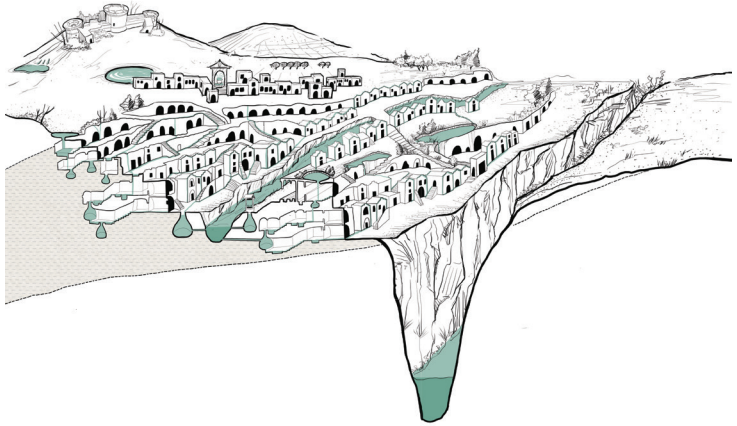
Traditional water system in Sassi di Matera



Precipitation and temperature in Matera



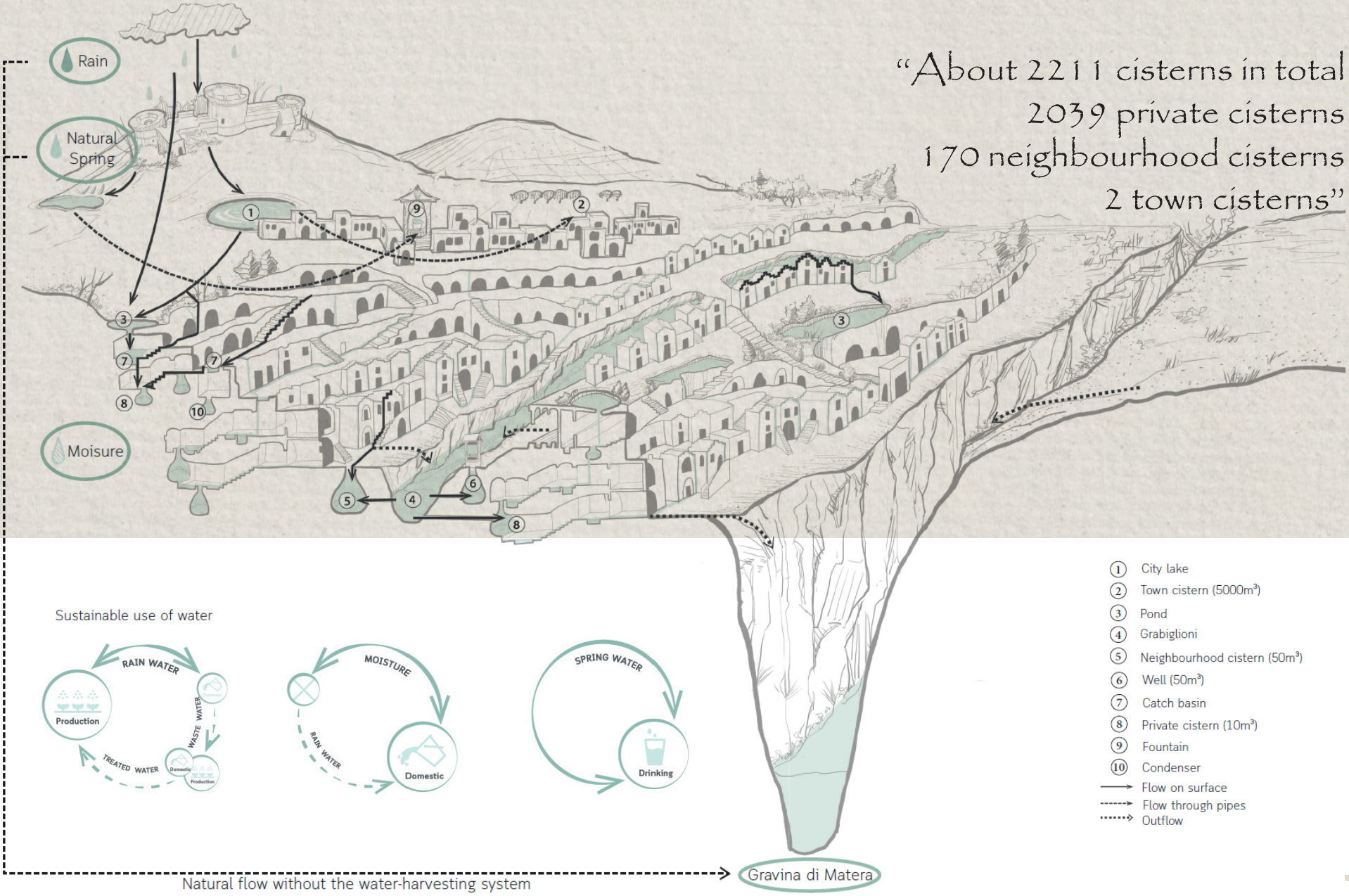
Primitive waterworks on limestone



Traditional water harvesting system in tuff

"Water" as a scarce resource

"About 2211 cisterns in total
2039 private cisterns
170 neighbourhood cisterns
2 town cisterns"



Sustainable use of water

1.2 Water wisdoms in Sassi di Matera



Cirluar System



Social Network



Green Space

What we can learn from the traditional water harvesting system in Sassi di Matera?

Circular system

There are three types of water source in Sassi, rain water, natural spring, and moisture. In a natural condition, they will directly go into the Gravina di Matera, but with the help of the circular water system, they are used in a sustainable way for production, domestic use and drinking purposes.

Firstly, the rain water, which is also the dominant source in Sassi, is collected in lakes, ponds or catch basins at first, then goes into cisterns of different sizes with the help of horizontal and vertical water channels on roof, stair, wall and ground. Some cisterns are interconnected by underground pipes, while others are quite private and isolated. There is also a water tank that is completely isolated, and it is used as the condenser to collect moisture, which is also a hidden water source in Sassi. In addition, a natural spring near Tramontano Castle is the only drinkable water source, which is later led to the Fountain Ferdinandea for people to use.

Social network

Social life in old Sassi di Matera is organized by the precious resource people shared together, the water, so the system of water works can be seen as a system of public space. This spontaneous social network is mainly supported by vicinato (always with cisterns shared by several families) and drinking fountain, and the former one was once compared to neighborhood unit in an American planning context. The biggest gathering place, Plazza Vittorio was built above the largest cistern for the whole town, with a volume of 5,000 m^3. The water channels called grabiglioni are the important lines in the social network, because the first settlements in Sassi started to develop and flourish along these two courses to the Sassi Barisano and Sassi Caveoso we see today.

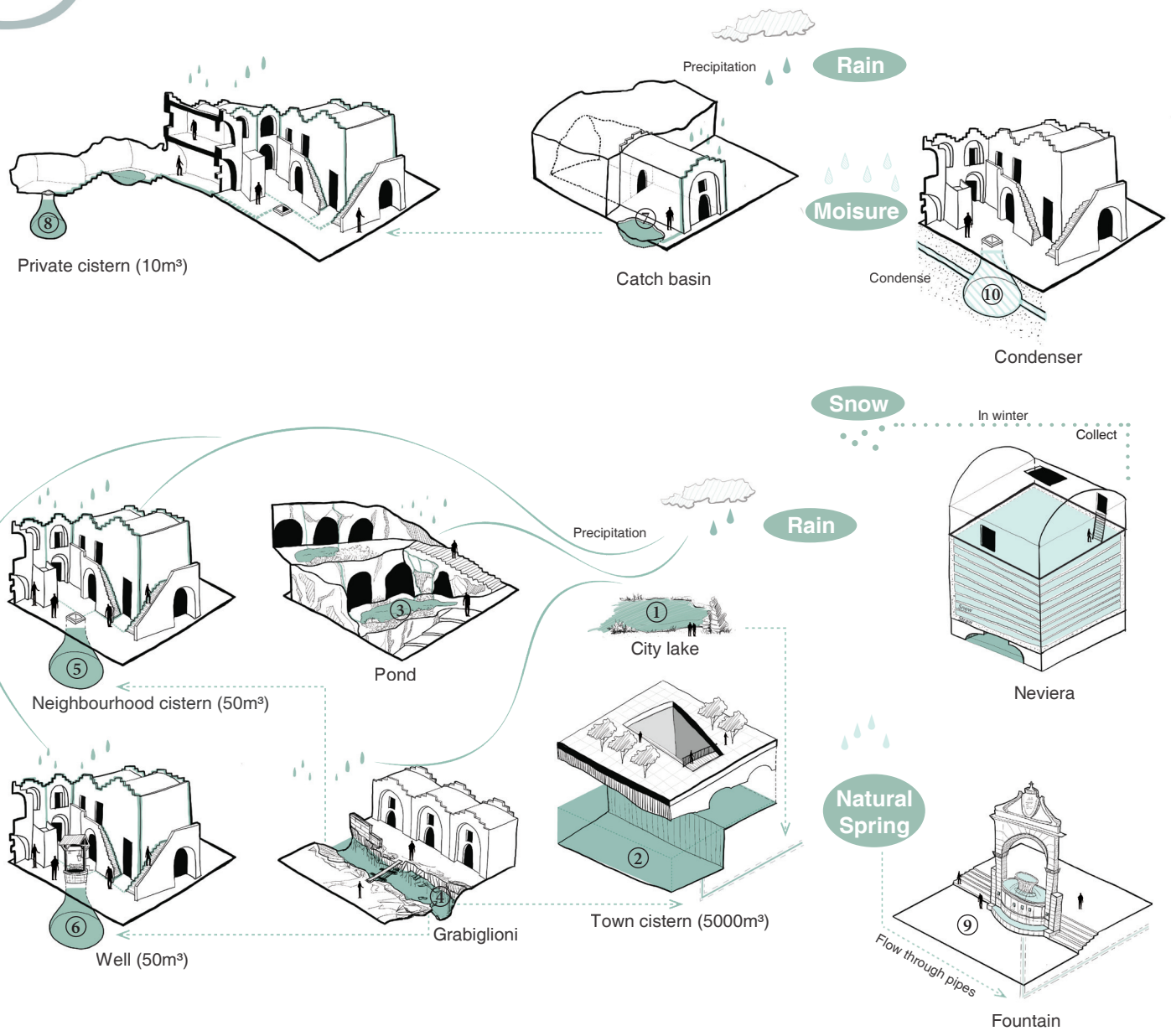
Green space

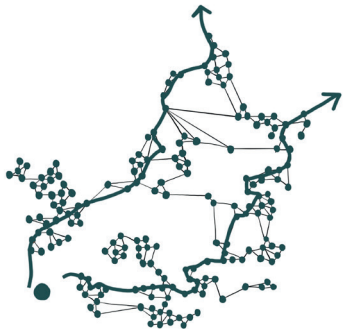
Where there is water, there is life. The water flows in the stone city, not only provides people with the resources they need, but also brings life to the khaki world. The most typical green space in Sassi is the roof garden, where water is purified and stored, where different flora and fauna can f lourish and interact with humans.

Conclusion

The traditional water harvesting system in Sassi di Matera is a perfect example, showing the harmonious relationship between human and nature where humans can live with water in a sustainable way. It is water that shaped Sassi physically, socially, and culturally. The water system itself is now too obsolete to be used, and the water space holding many cultural and social values is forgotten. However, it is important to preserve it and to show that collecting rainwater, being sustainable in reuse and sharing it's not only a demand of the climate change times, but was done ages ago to be able to survive. This is something to learn from - to preserve and to pass on to future generations - even to understand it and adapt it to current challenges.

Cirluar system





Connected water space

Rainwater is used as a public resource. Most cisterns rely on the rain water collected by the small channels with the buildings nearby. However, the *grabiglioni*, as the most important water channel in Sassi, is also the water supply for nearby cisterns.

Rainwater is also collected each house. The natural caves are enlarged digging deep in a sloping direction, in order to allow either the harvest of water flow and the natural lighting. Private cistern is always of smaller size about 10m³, and catch basins and water channels of different levels help water run smoothly and become more and more clean. The City of the Sassi also has evidence of neviera, in which snow taken from roofs and streets was stored by piling it inside from above, interspersed with layers of straw as insulation, to produce ice.

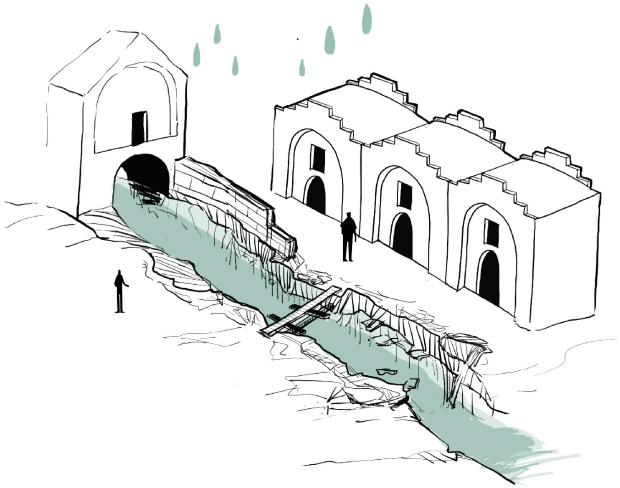
The *grabiglioni* were drainage channels that flowed into the Gravina stream, near Matera, and channeled both rainwater and wastewater.

Social network



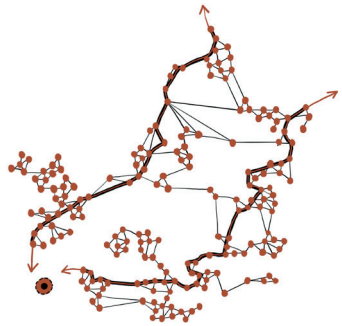
Vicinato
(with neighbourhood cistern)

social intercourse & domestic chores
Climate: Warm mediterranean climate
Water type: Rainwater
Meaning: Domestic and agricultural use



Grabiglioni (natural water channels)

social intercourse & domestic chores
Climate: Warm mediterranean climate
Water type: Rainwater
Meaning: Domestic use



Neighbourhood unit

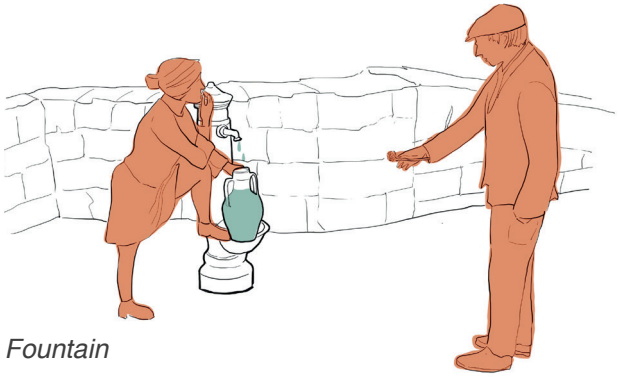
The *vicinato*, a common courtyard where children would play together and everyone helped each other out, is always accompanied with a cistern serving 4-6 families, so it naturally becomes the place for different domestic chores and social interactions. Woman had to collect drinking water for the family from fountains at that time, and sometimes young people would meet at the spot.

Public line

Most cisterns rely on the rain water collected by the small channels with the buildings nearby. However, the *grabiglioni*, as the most important water channel in Sassi, is also the water supply for nearby cisterns. This natural water suppler made itself the center of the living area and social center of Sassi.

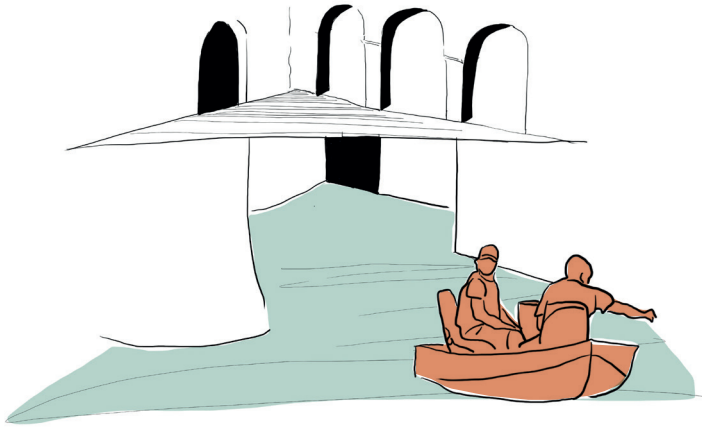
Public center

Town cistern (5000m³) is not only where all citizens share the water, but also the center of public life because of the plaza on top of it.



Fountain

getting of drinking water & meet of young people
Climate: Warm mediterranean climate
Water type: Spring water
Meaning: Drinking

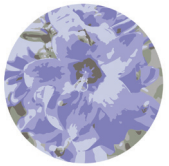


Plazza vittorio (with Palombaro lungo)

social intercourse & domestic chores
Climate: Warm mediterranean climate
Water type: Rainwater
Meaning: Domestic and agricultural use



Caper



Apulian bellflower



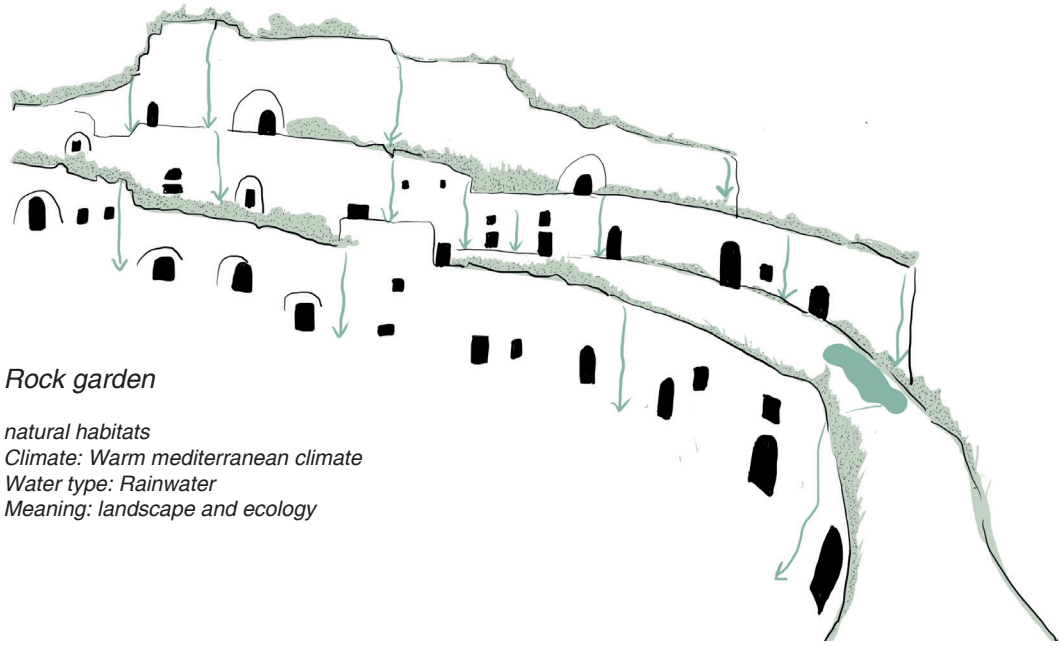
Navel of Venus



Polio camedrium

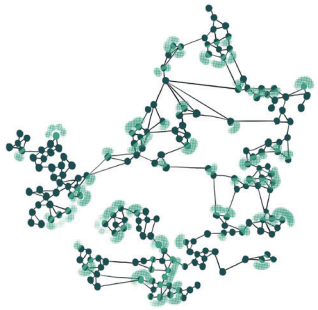


Lucania fennel



Rock garden

natural habitats
Climate: Warm mediterranean climate
Water type: Rainwater
Meaning: landscape and ecology



Green space

The lake and pond become the natural gardens for people to get close to nature, and the place for flora and fauna to survive. Birds inhabit under the eaves of every household. Due to the crisscrossing rainwater channels in the city, many rock vegetations, such as caper, Apulian bellflower, and the Navel of Venus, bring color and vitality to the rock city.

This is the intersection point of man-made environment and natural environment, an example of harmonious coexistence of human and natural world.



Figure 2.1



Figure 2.2



Figure 2.3



Figure2.4



Figure 2.5



Figure 2.6

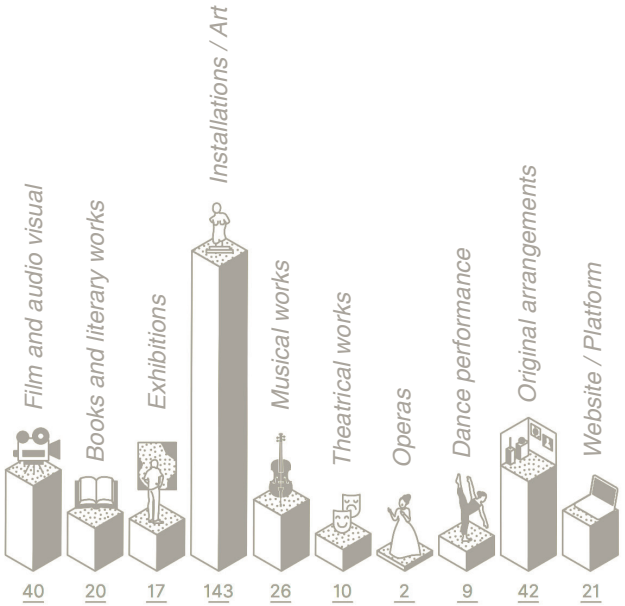


Figure 2.7

02 INTRODUCTION

2.1 Context of Matera


Figure2.8



The municipality of Matera is located in Basilicata region, southern Italy, and its population is about 59,869 (2022). As Matera became an attractive cultural destination after the reputation of European capital of culture in 2019, more and more people from home and abroad were drawn to Matera, more precisely to Sassi di Matera. Numerous cultural and creative activities brought vitality to the ancient city. One the one hand, it made big contribution to the local economy. The statistics from the City-O study reveal the GNP (Gross National Product) of the city of Matera reaching the amount of 224.3M € in 2019, of which tourist spending accounts for 121.3M €. One the other hand, the international fame of Sassi also made the rest of the city an invisible part. The local rural landscape, stunning natural landscape, as well as the rural and urban life are still unknown to most visitors, and the life of local out of Sassi seems to be separated from that booming cultural icon. There's a need to consider the landscape and value of Matera as a whole part, to coordinate the development of surrounding areas and Sassi rather than exacerbating their differences and imbalances.


Figure2.9

The research in the first chapter argues that the internal mechanics of Sassi di Matera makes it the Hidden Water City, and it highlights its water circularity, social and natural values. Water is the most important element in both Sassi and city Matera. So, the research of the city Matera will also start with water, then shift to the social and natural aspects. It will be delivered in these three parts to show the disconnections in the region regarding water usages, settlements and natural areas.

Figure 2.1: Cultural transformation of caves in Sassi di Matera, https://www.matera-basilicata2019.it/it/
Figure 2.2: Sassi di Matera for tourists, https://www.123rf.com/photo_124727116_panoramas-of-the-ancient-medieval-city-of-matera-in-italy.html
Figure 2.3: Sassi di Matera with nature, https://www.earthtrekkers.com/best-things-to-do-in-matera/
Figure2.4: Nature in Matera, https://www.lagazzettadelmezzogiorno.it/news/matera/1023156/in-mountain-bike-per-scoprire-il-parco-della-murgia-materana.html
Figure 2.5: New urban area in Matera, https://www.f loornature.com/materaas-new-central-train-station-designed-stefano-boeri-ar-15096/
Figure 2.6: Rural village in Matera, https://www.pietroamendolara.it/borgo_la_martella_matera-p19920?_mob=1#pid=2
Figure 2.7: Rural landscape in Matera, https://www.f lickr.com/photos/clodiophotography/49390847401/in/photostream/
Figure 2.8: Aerial view of Sassi di Matera, Kaspars Upmanis/unsplash.com
Figure 2.9: Cultural activities and works in 2019, https://www.matera-basilicata2019.it/it/

Mapping of water network



Natural water system

- Water
- Sassi di Matera



Agricultural water system

- Multifuctional water pipe
- Agricultural water pipe
- Water
- Farmland

Water timeline

Natural water system

Surface

Sub-surface

Palaeolithic times

Metal age

Primitive water works

Rainwater harvesting system

1900

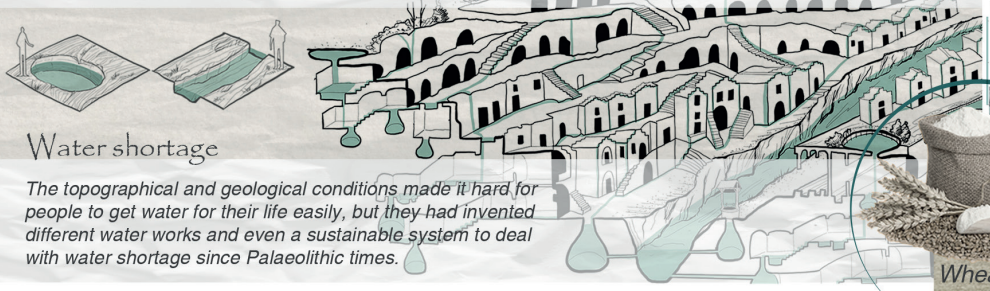
Drinking fountain **Sele aqueduct and pipes** **San Giuliano** **Transformation of grabiglioni to sewer**

1950s

Seperate underground pipe system

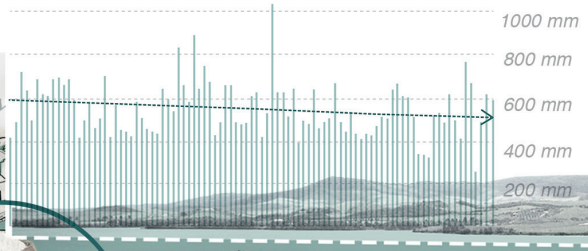
Shrinking natural water s

Water challenge



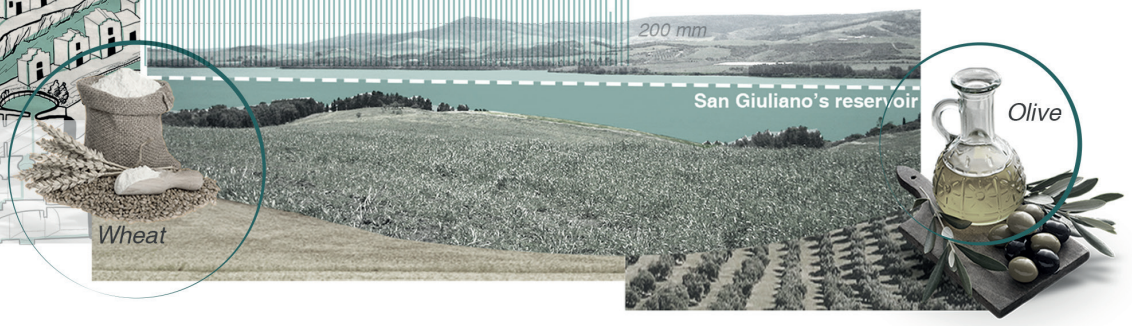
Water shortage

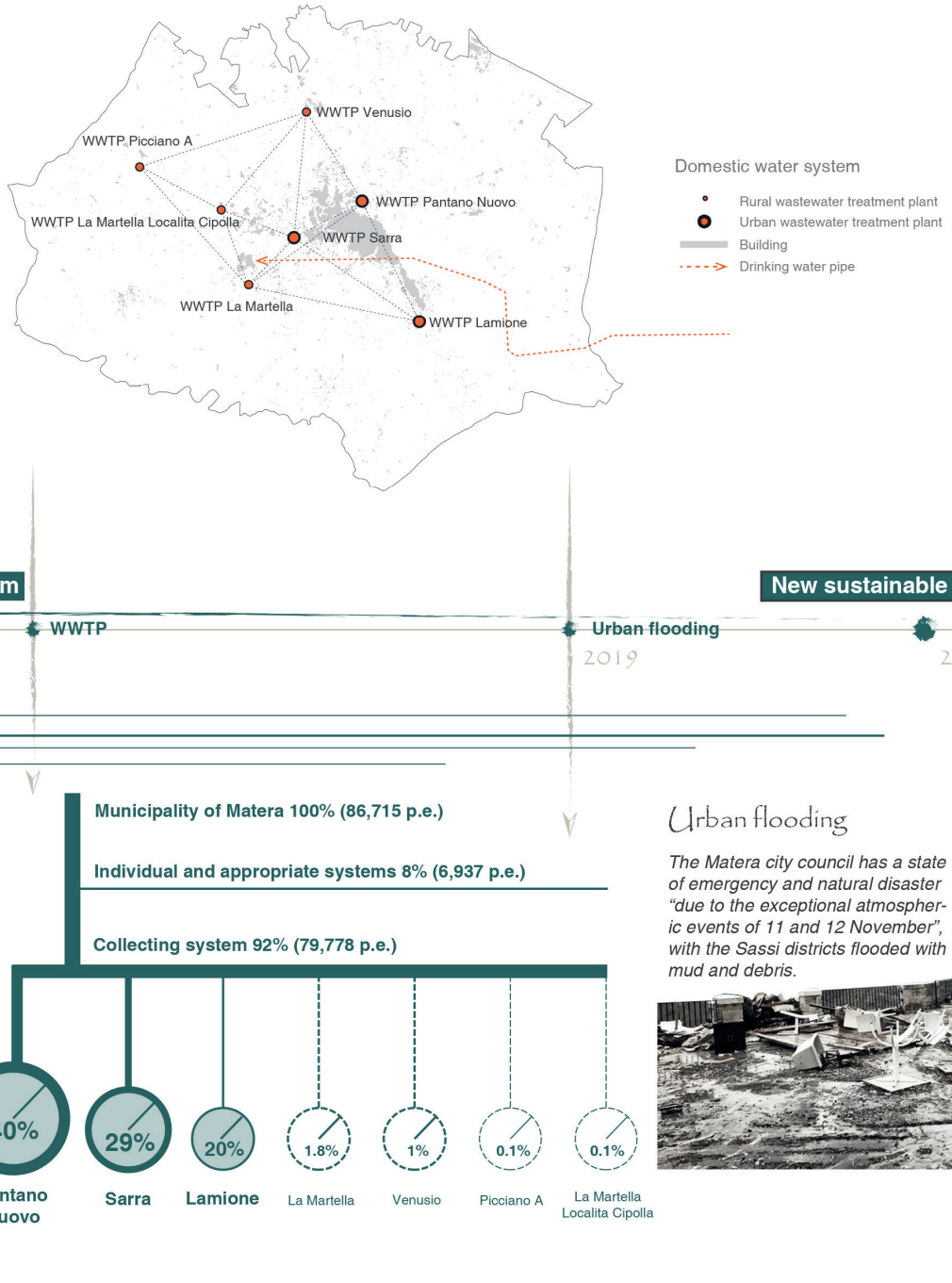
The topographical and geological conditions made it hard for people to get water for their life easily, but they had invented different water works and even a sustainable system to deal with water shortage since Palaeolithic times.



Declining rainfall

There is a decline in average annual rainfall due to climate change, with the statistics from 1992 to 2014.





2.2 Major challenges:
disconnection between water uasges

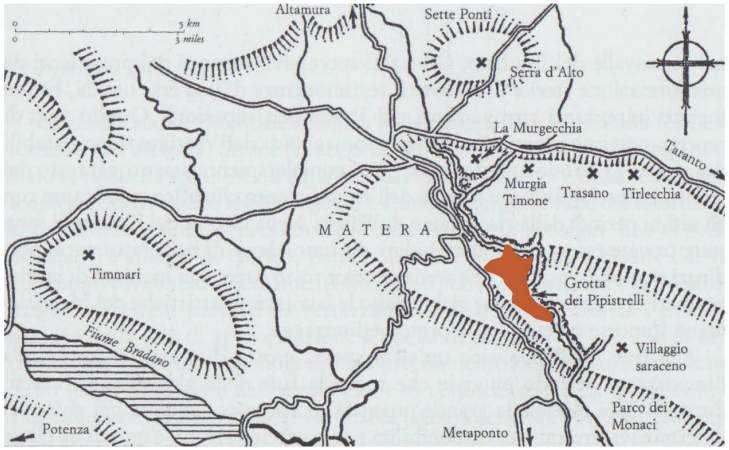
Sassi di Matera is located along a stream called Gravina di Matera, which belongs to the catchment area along with Gravina di Picciano and Stream Jesce and finally goes in to the Bradano river.

The traditional water harvesting system which used to help combat the semi-dry climate in Sassi di Matera gradually disappeared due to the urbanization and deteriorating sanitary issues. The pipe works took its place and became the new hidden network of city since 1900s. The artificial reservoir for irrigation, called *San Giuliano*, supplies water to the Bradano-Metaponto consortium, i.e. to the 31 municipalities of Matera Provence. However, with declining rainfall caused by climate change in recent years, the Bradano-Metaponto is defined as an area under desertification risk. The climate crisis also brought exceptional atmospheric events in Sassi, posing a threat to the protection of cultural heritages. In dry summer, the surface water body in city Matera is mainly made up of the wastewater produced at different treatment plants, but the poor water quality does harm to natural habitats.

Water needs to be put into use more in a more sustainable and ecological way, to deal with the water shortage, urban flooding and wastewater pollution. The lost cultural value and hidden image of water also need to rediscovered.

Figure 2.10: https://www.wantedinrome.com/news/matera-european-capital-of-culture-seeks-state-help-after-devastating-floods.html

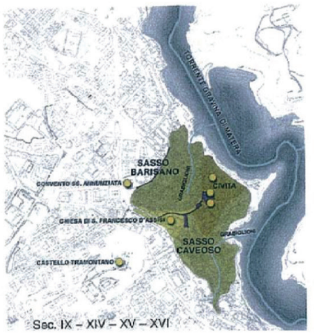
Mapping of settlements through history



Distribution of prehistoric settlements

Future location of Sassi di Matera







Development of Sassi di Matera



Social timeline

Prehistoric settlements

Palaeolithic times — **Bat cave** karst caves of ritual

Neolithic times — **Murgia Timone** primitive villages

Metal age — **Sassi di Matera** cave dwellings

Civita — **Sasso Caveoso** — **Sasso Barisano**

16005 — **Piano**

1952 — **Eviction of Sassi** special law

1954 — **La M** rura



THE NEOLITHIC AGE (5.000 – 4.000 B.C)

Stone city



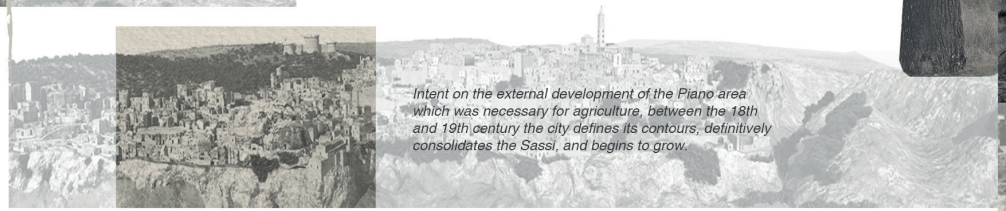
During these centuries the city becomes a fortified urban centre in the Civita area.

THE BYZANTIUM AND NORMAN PERIOD (IX – XII CENTURY A.C.)



SWABIAN – ANJOU PERIOD (XIII – XIV CENTURY A.C.)

Around the Civita numerous rupestrian churches and monastery's are built. The Sassi settlements grew in number becoming part of the urban definition. The Sassi settlements are extended and consolidated.



Intent on the external development of the Piano area which was necessary for agriculture, between the 18th and 19th century the city defines its contours, definitively consolidates the Sassi, and begins to grow.

LATE 19TH CENTURY (1875 – 1898)

National shame

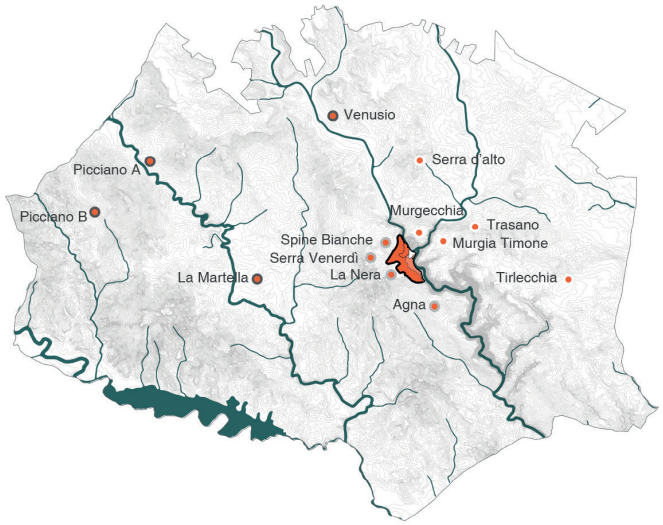
In 1952 the town was labelled as the special law was enacted to order the inhabitants left the ancient center and



Social challenge

Agro-pastoral life style

People struggled to find an ideal habitat for conducting the two activities on which they would base their livelihood: raising sheep and agriculture.



Distribution of settlements

- Prehistoric settlements
- Typical urban housing projects
- Typical rural housing projects
- Civita
- Sasso Caveoso
- Sasso Barisano
- Piano

rsed housing projects

New possibility of social life?

Martella
l project
1959
Spine Bianche
urban project
1993
Sassi di Matera
UNESCO Heritage
2019
Matera
European Capital of Culture
2023

New cultural centre

"national shame" because of its poor living conditions. A
evacuation, and from 1950 to 1960, about 15.000
d moved to newly built houses up hill and in the fields.

Cultural destination

Sassi di Matera is becoming the most attractive place for both locals and visitors as the cultural destination.



Rural housing

Urban housing



2.3 Major challenges:
disconnection between settlements

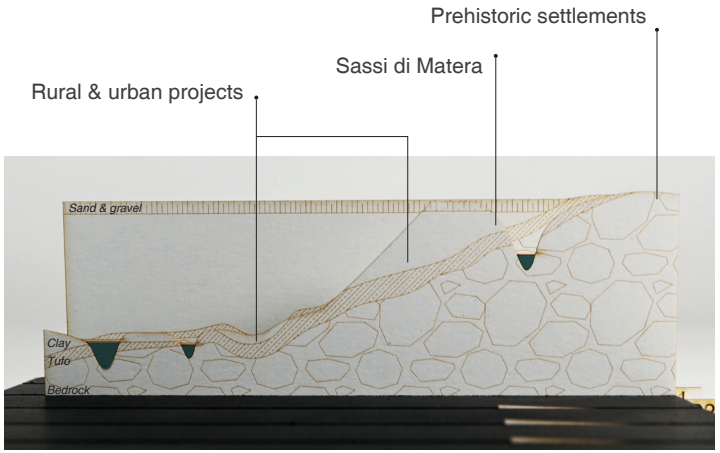
Matera city had the traces of human life dating back to paleolithic times. Initially, local inhabitants settled into a series of caves in limestone, for example, the Bat Cave which serve as sacred burial, shrine and temple. About neolithic times, there's a transition from nomadic to agro-pastoral life style. People were found living in villages made of huts on the highland, which was an ideal place for agricultural activities.

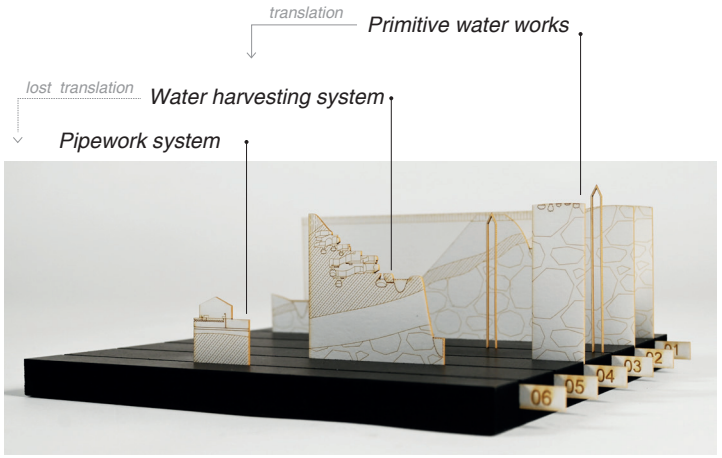
The flourish of the ancient Sassi di Matera carved in local soft rock (tuff) started with Civita as a fortified city, then later the Sasso Barisano and Sasso Caveoso came into being along the natural torrents called *grabiglioni*. This stone city with hidden water system is like an organism, revealing its sustainable traditions. Beginning in the seventeenth century, however, the second movement of population shows hierarchical ordering of space by class, with the rich Materans moving to the flat plain above the ravine, called the piano.

In 1952, the biggest movement and the separation from Sassi started with the label of "national shame" because of its poor living conditions. People moved to newly built houses up hill and in the fields. After the reputation of Sassi, funds were raised to bring dwellers back to the city. Tourists are also becoming temporary residents in Matera. Matera is transforming into an attractive city abundant in cultural heritage and creativity.

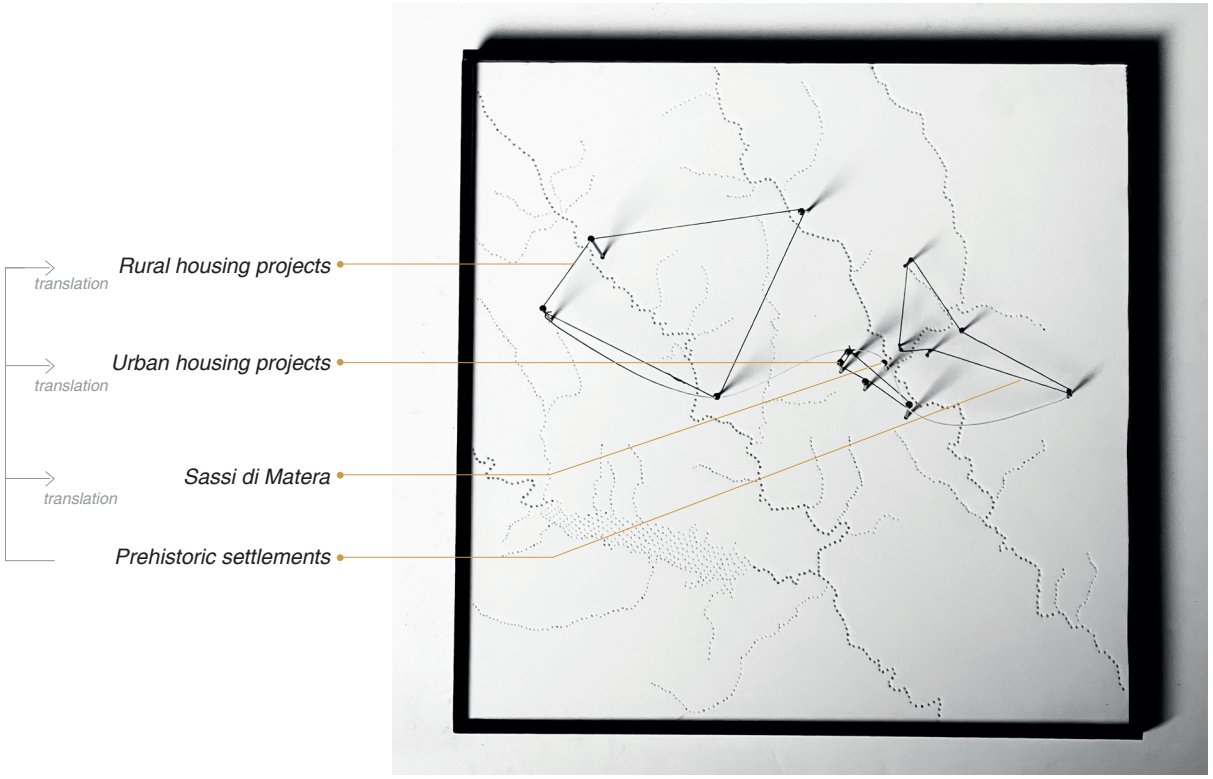
The social and cultural separation in Matera, as well as the relationships between locals and visitors need to be addressed. The future vision of a creative Matera should also involve its original rural and natural landscape.

Figure 2.11: http://www.materacittanarrata.it/mSite/pp.asp?lang=2&pan=2&ep=3

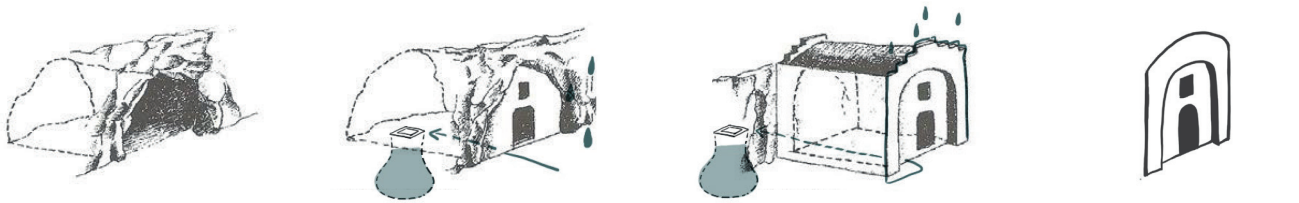




Comparison between water works



Distribution of settlements



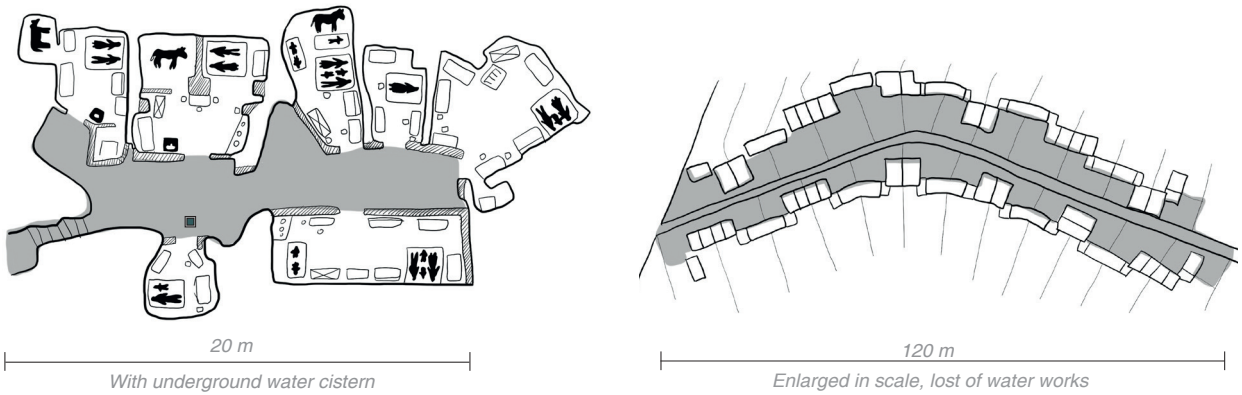
Natural cave

Closed cave:
cistern for water storage

Lamione as extension:
roofs built for rain harvesting

Duplex facade:
lost of water features

Transformation from cave to modern dwelling, Spine Bianche as an example



20 m

With underground water cistern

120 m

Enlarged in scale, lost of water works



Figure 2.12



Figure 2.13

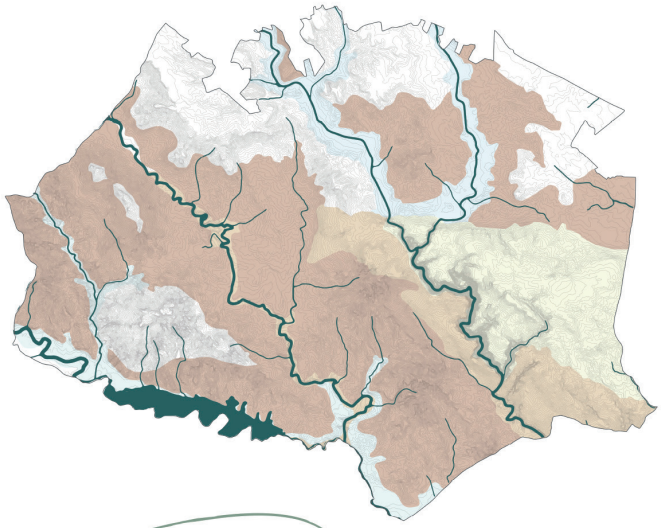
Transformation of Vicinato, La Martella as an example

There are three types of settlements I found very interesting during my research, the prehistoric settlements based on limestone, the cave dwelling of Sassi di Matera carved out of local tuff, and numerous urban or rural housing projects on flat clay land. They have different topographical and soil conditions, but they do show the continuity of the idea of living in a dry region as well as the lost tradition of rainwater harvesting.

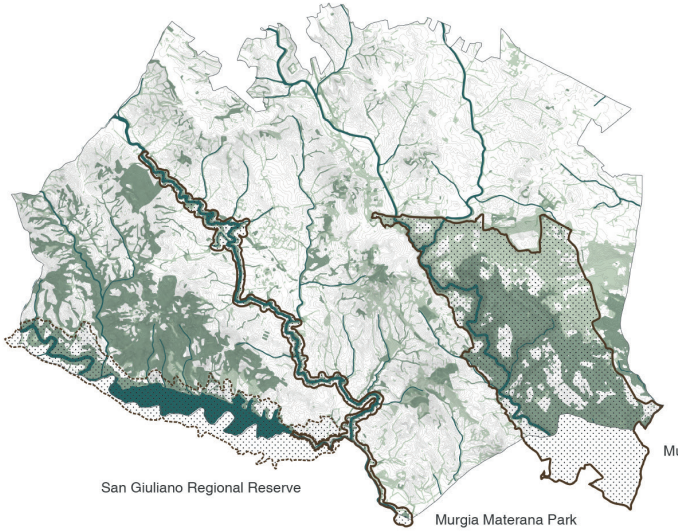
Since the 1950s, due to urbanization and deteriorating living environment, the residents of Sassi have been evicted by the government. People started moving in the new rural and urban housing projects not only inf luenced by american planning theories, but also by the social practices originated from the old system. But the interpretations of the old system are always only about their form, spatial and social characteristics, ignoring the water as the crucial elements behind their physical existence. The first example shows the loss of water feature during the interpretation of local architecture called Lamione in a urban project, Spine Bianche; and the second gives an example of public space called *vicinato* in a rural village, La Martella.

Figure 2.12: Photo of vicinato and neighbourhood in Sassi di Matera
Figure 2.13: Photo of new vicinato and neighbourhood in La Martella

Mapping of natural system



Soil type
- Clay
- Tuff
- Limestone
- Floodplain
- Sand and gravel
- Water



Green space
- Water system
- Densely vegetated
- Loosely vegetated

Ecological timeline

Deforestation and soil degradation

Palaeolithic times — **Dense forest**

Classical period

Colonial agriculture 1700s

Commercial agriculture 1800s

After WWII 1950s



Ardea alba

Recurvirostra avosetta

Farming and land reform

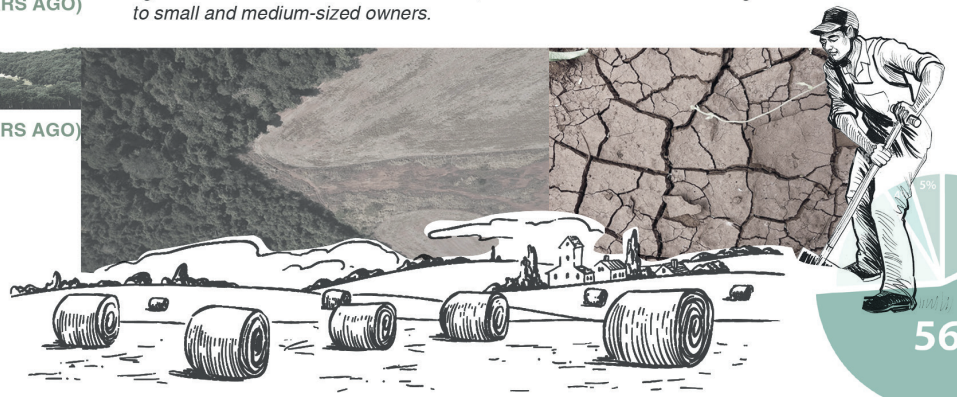
The vitalisation of the region's economy from the sixteenth century led to continuous deforestation and soil degradation, a result of local mono agriculture. In the land reform after WWII, lands were transfered from large to small and medium-sized owners.



THE SUPERIOR PLIOCENE AGE (2 MILLION YEARS AGO)



THE CALABRIAN PLEISTONCENE AGE (1 MILLION YEARS AGO)



Value nature

San Giuliano Regional Reserve is characterised by three different habitats: the natural lake, the riparian fringe, and a rocky ravine. A broad temporarily flooded meadow extends between the planted woodland and the lake edge.

Murgia Materana Park stretches out across 8.000 ha and it's located partly on a rocky plateau and partly on one side of the canyon created by the Gravina stream.

Agriculture & Husbandry

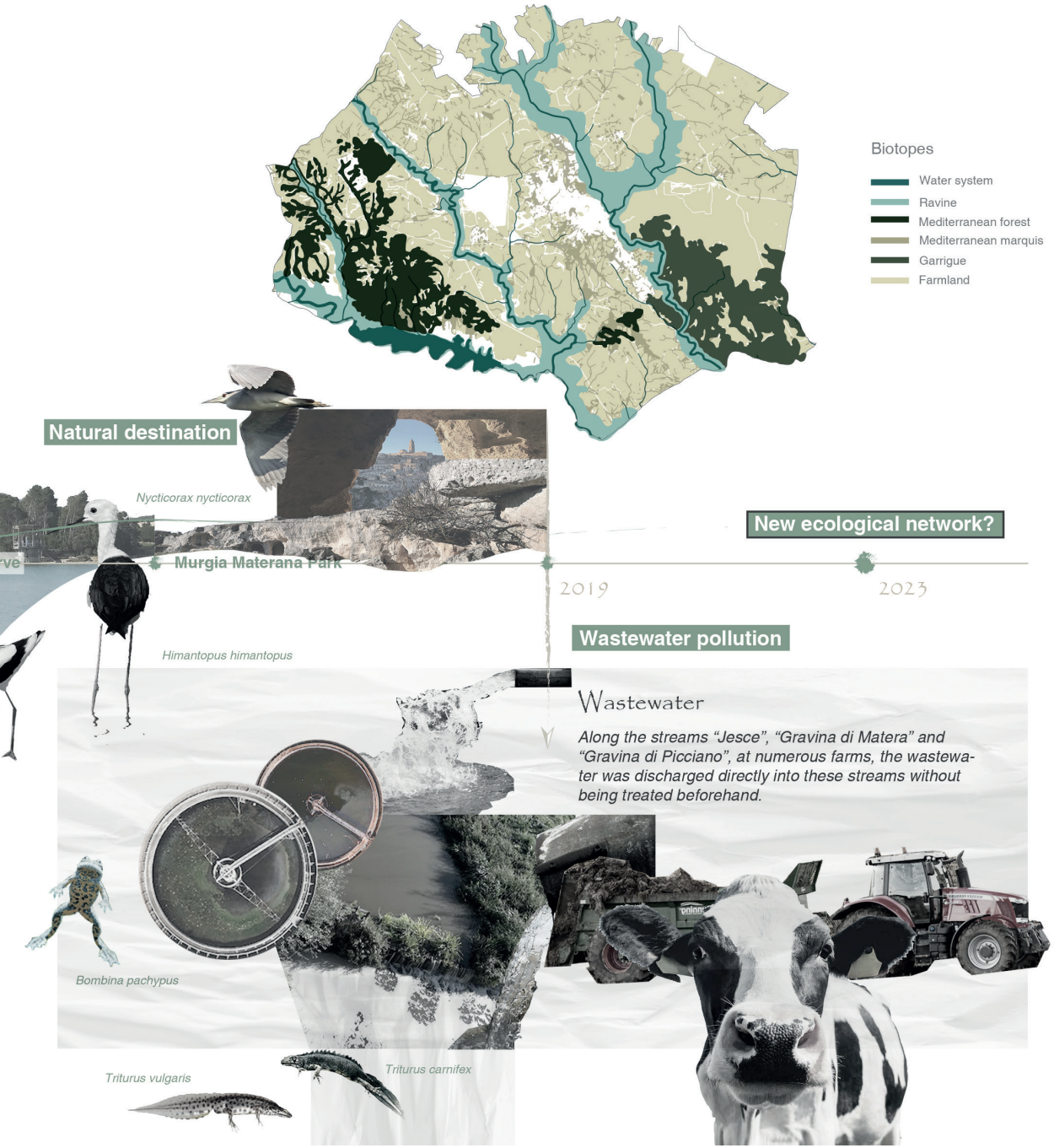
Agriculture & Husbandry | Artisans & Shopkeepers | Housewives | Wealthy & Professionals | Others

Occupations and work (1754)
with a total of 11170

Ecological challenge

Land

The earth begins to emerge and gives rise to the sedimentation of sand and gravel along the coastline. The vegetation is a very dense maquis.



2.4 Major challenges:
disconnection between natural areas

The cereal monoculture in Matera starting from the classical period makes deforestation and soil degradation a serious problem. The dominant crops are wheat and olive, which can stand the semi-dry climate. The revitalization of the region’s economy from the seventeenth century led to a renewal of deforestation. By the eighteenth century quite widespread thinning had begun, such as that around the relatively prosperous city of Matera.

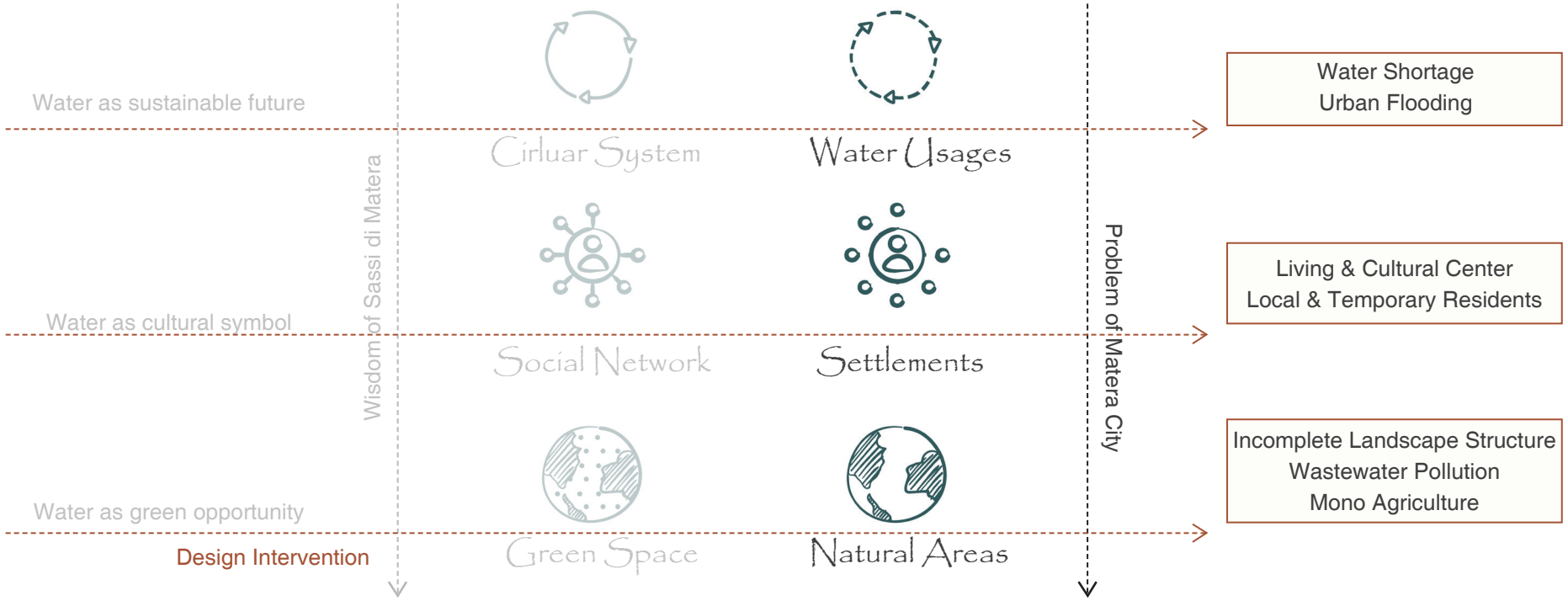
After the WWII, in addition to practicing the usual cereal monoculture, there was a change of land owners as a result of the announced land reform. Lands were transferred from large to small and medium-sized owners.

Apart from vast agricultural lands, the local natural landscape is very characteristic and diverse. The biotope varies from Mediterranean forest, Mediterranean maquis, garrigues, to the habitats at the bottom of the ravine. The landscape and ecological values of these natural areas are being taken into consideration. The San Giuliano Reserve and the Murgia Materana Park are the places where local f lora and fauna are being protected.

However, the landscape structure and routing system are not very complete in the regional scale, with the two parts of Murgia Materana Park not well connected. The outflow of wastewater also poses a threat to habitats near natural streams. A balance needs to be found between the agricultural practice and natural values. The potential of a more sustainable agriculture, a better blue-green network can be the key to enhance the livability and resilience of Matera.

Figure 2.14: http://www.materacittanarrata.it/mSite/pp.asp?lang=2&pan=2&ep=3

2.5 Problem statement & Research question



Research Question

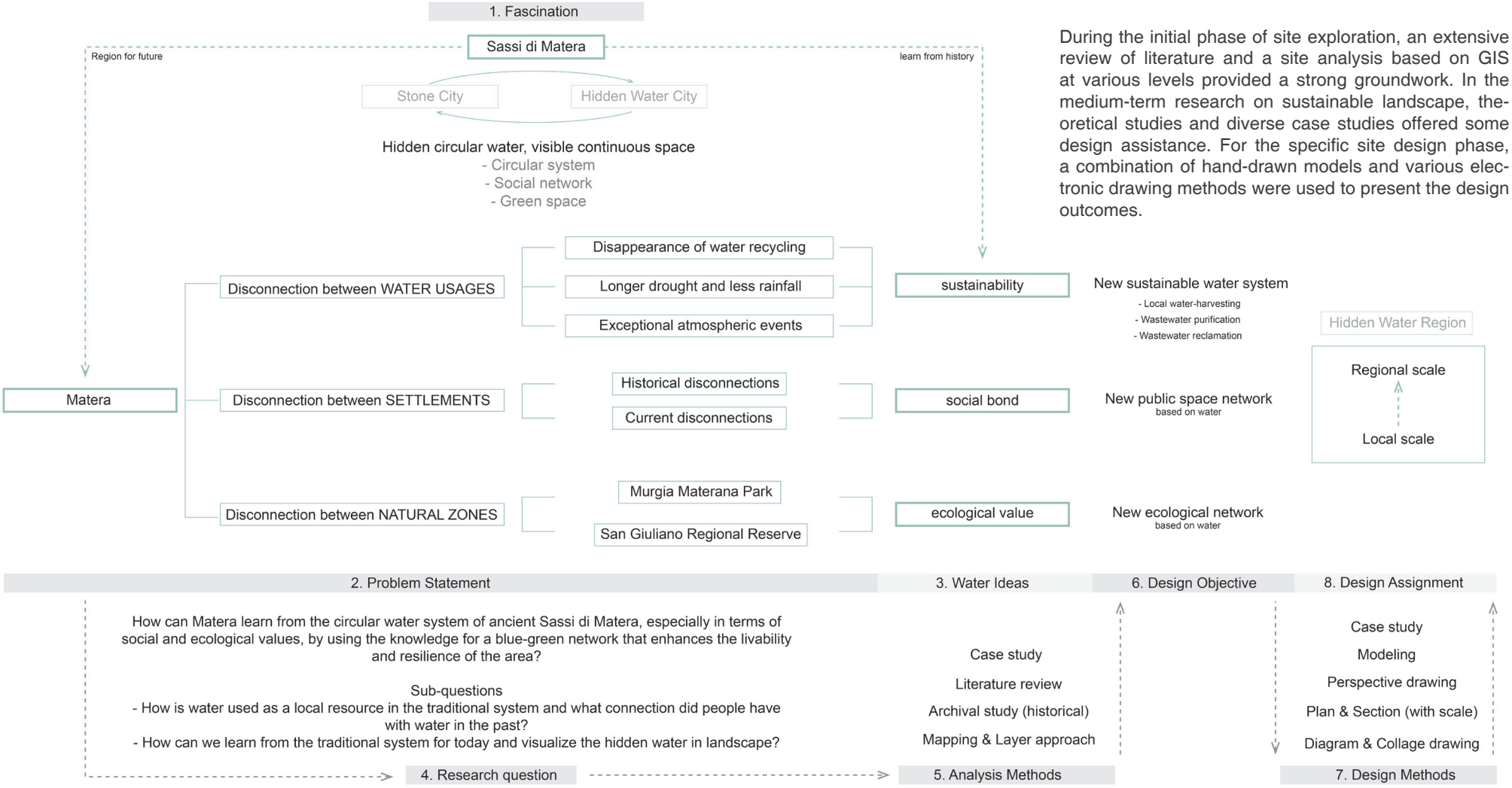
How can Matera learn from the circular water system of ancient Sassi di Matera, especially in terms of social and ecological values, by using the knowledge for a blue-green network that enhances the livability and resilience of the area?

Sub Questions

- How is water used as a local resource in the traditional system and what connection did people have with water in the past?
- How can we learn from the traditional system for today and visualize the hidden water in landscape?

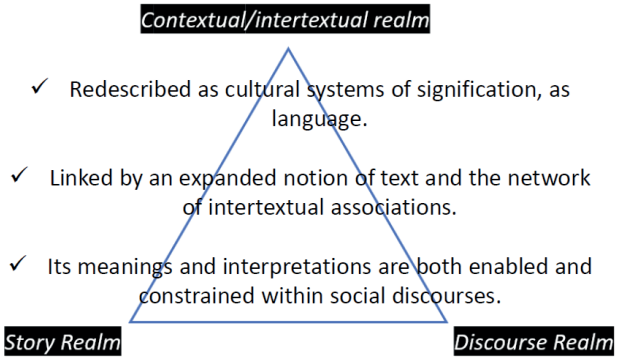
03 METHODOLOGY

3.1 Workflow



During the initial phase of site exploration, an extensive review of literature and a site analysis based on GIS at various levels provided a strong groundwork. In the medium-term research on sustainable landscape, theoretical studies and diverse case studies offered some design assistance. For the specific site design phase, a combination of hand-drawn models and various electronic drawing methods were used to present the design outcomes.

3.2 Theory:
Landscape narratives



Landscape narrative is a landscape theory proposed by Matthew R. Potteiger and Jamie Purinton, and it provides support for designing intangible cultural heritage in this thesis. Using a narrative-descriptive approach, the story of hidden water can be expanded, organized and transformed into authentic existences.

Three realms in landscape narrative:
The story realm is the world of the story itself, and water will be the most crucial clue in the water story of Matera. Cisterns of different sizes, water channels carved in rock, and the public space related to waterworks in Sassi di Matera are the historical parts of the story, while the proposed wastewater purification and reuse in surrounding rural lands will tell the modern water story. The journey of water in Matera spatializes the temporal language. On the one hand, it shows a continuous story where people live with water in a sustainable way; on the other hand, it displays various ways of using water from rainwater collection to wastewater utilization.

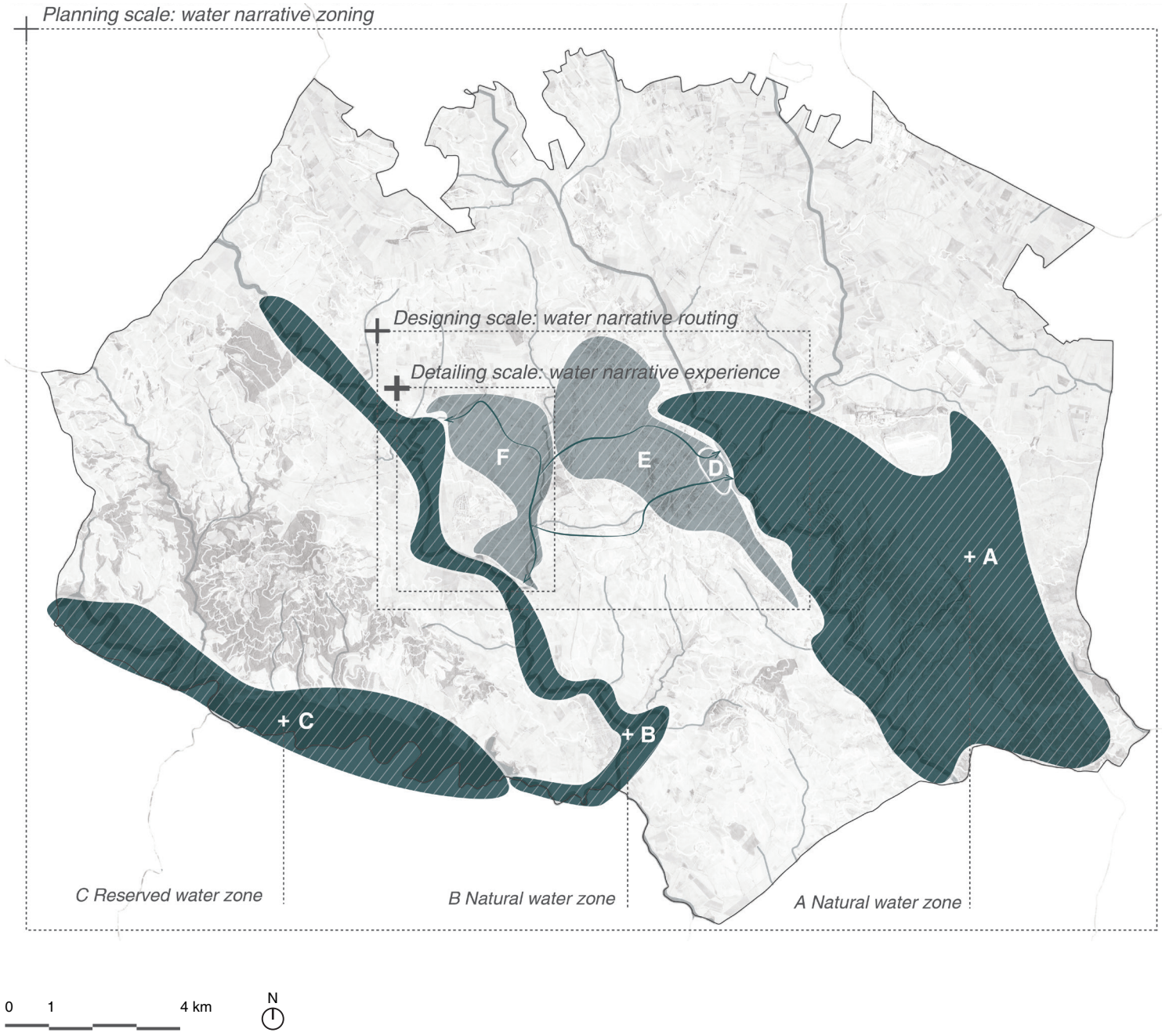
The contextual/intertextual realm affirms that stories are interrelated with aspects outside themselves and will be interpreted by readers from different backgrounds. The new water design not only solves the water crisis in Matera but also brings insights to other dry rural areas in southern Italy. Besides, case studies of water harvesting and water reuse in other dry areas will also contribute to the design. It is also necessary to keep in mind that the water story in Matera will be read by both locals and visitors because the reputation of Sassi di Matera as a cultural heritage has already brought lots of people here.

The discourse realm reveals another role of landscape narratives in negotiating and constructing values, beliefs and ideologies. Sustainable design is the focus of my proposal, and it is the narrative of environmental crisis that creates its imperative nowadays.

Application:
The story realm is applied to design in different scales. In the planning scale (municipality of Matera), different zones of water are proposed to connect current natural areas. And these three newly proposed water zones correspond to three characteristic water elements in Matera respectively, the grabiglioni in Sassi di Matera, the public fountain across the city, and the wastewater facilities in the edges of city.

In the designing scale, water narrative routings are proposed to construct a diverse journey of water across different water zones. To enhance the efficiency and user experience of route planning, various modes of transportation and different types of users are taken into account. This approach aims to create more effective and enjoyable routes within a given area.

In the detailing scale, the water story hidden in the rural landscape will be visualized and elaborated by discovering various new representations of water. By incorporating the narrative of water into design, the transformation from stone city to hidden water region is visualized. This approach encourages people to explore the hidden stories of water, and helps locals reclaim their lost water identity within the landscape.

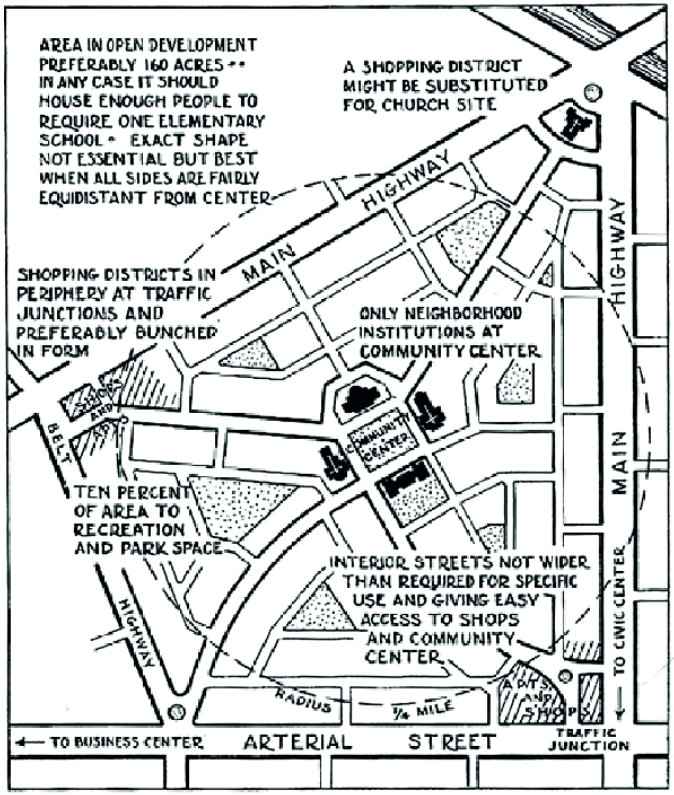


D Sassi grabiglioni zone

E Urban fountain zone

F Reclaimed water zone

3.3 Theory:
Neighbourhood unit & 5-minute walk



The neighborhood unit was a planning model for residential development in urban areas that was created by Clarence Perry in the early 1900s. This thesis aims to guide community life and preserve cultural heritage by rebuilding public fountain units, using the theory and the idea of five-minute walk.

Neighbourhood unit:
This concept was based on the prevailing social and intellectual attitudes of the time and was intended to provide a framework for urban planners who were seeking to design self-contained and functional neighborhoods in rapidly industrializing cities. Perry's goal was to create a cohesive unit that would incorporate all necessary elements within a single neighborhood. One of the ideas is to allocate a minimum of 10 percent of the land area in a neighborhood to parks and open spaces, with the aim of creating areas where people can play and interact with one another as a community.

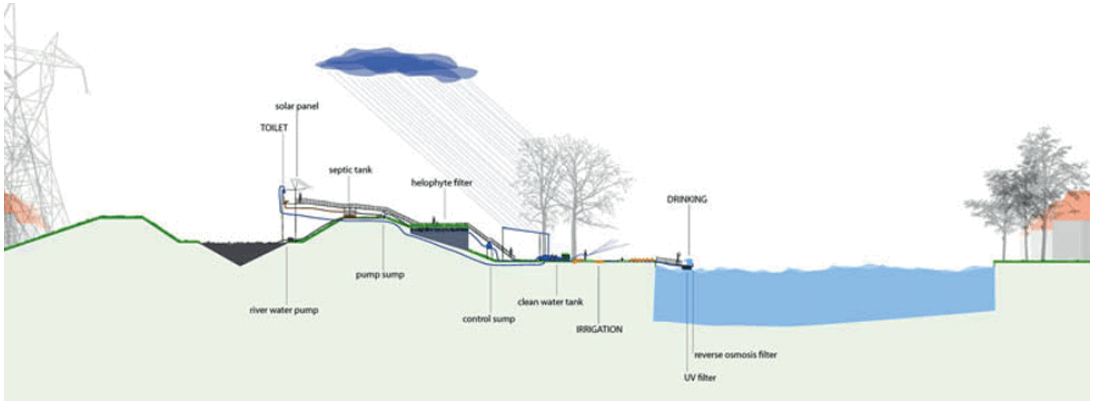
5-minute walk:
The idea of the 5-minute walk can be linked to the "neighborhood unit" concept. The 5-minute walk, also referred to as the "pedestrian shed," indicates the distance people are willing to travel on foot before considering other modes of transportation. This concept is based on the average walking speed and is represented by a radius of about ¼ mile or 400 meters. This guideline is often used to determine access to different locations within neighborhoods or to calculate the coverage of public transportation.

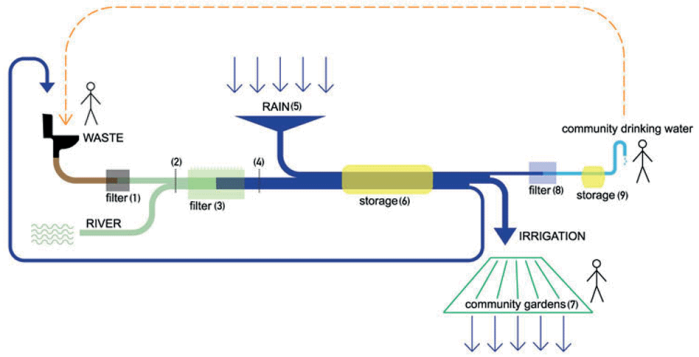
Application:
In the 1950s, the research and redefinition of *vicinato* in the context of the community unit theory in Sassi di Matera provided the foundation for design.

The abundant presence of public fountains in cities has presented a new opportunity for community units. While these fountains have historically symbolized the water cycle of Matera, they have gradually lost their social significance. By utilizing the concept of the five-minute walking distance to plan scattered public spaces within the city, it is possible to address the current issues of insufficient public space and a declining sense of community life. Additionally, this approach can encourage residents to reestablish their connection with water.

Figure 3.1: Diagram of neighbourhood unit, https://en.wikipedia.org/wiki/Neighbourhood_unit

3.4 Case study:
Between the Waters by Ooze and Marjetica Potrc











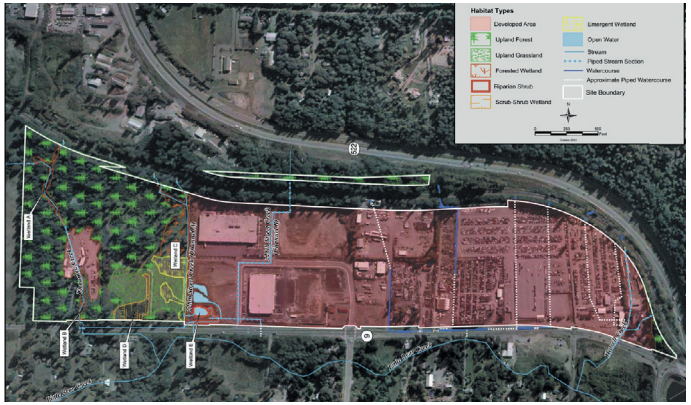
The collaboration between Rotterdam and Paris-based architecture firm Ooze and artist Marjetica Potrc has resulted in the creation of Between the Waters, a community garden and water treatment plant located on an island in Essen, Germany. The project involves the collection of different types of water, including rainwater, wastewater, and water from the Emscher River and Rhine-Herne Canal.

Visitors to Between the Waters can see the water treatment process in action as it is processed and cleaned in a visible installation, which is designed to educate them about the various stages of water treatment that typically happen out of sight. The community garden walkway leads uphill to the water processing installation, culminating in a platform over the river that provides a view of the waterways. The journey through the project begins at the Rhine-Herne Canal entrance to the Community Garden and continues beside the fully exposed water supply and treatment installation.

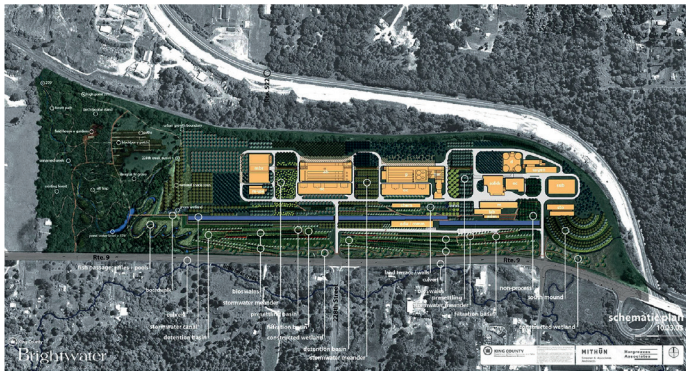
The project is a complete and sustainable water-supply system. The hidden water is brought to attention through the juxtaposition of shape, color, and the natural environment that surrounds it. It provides a reference for the sustainable utilization of color, form, and water resources in this thesis. In addition, how to organize artificial construction in accordance with local conditions has also become one of the topics for subsequent designs.

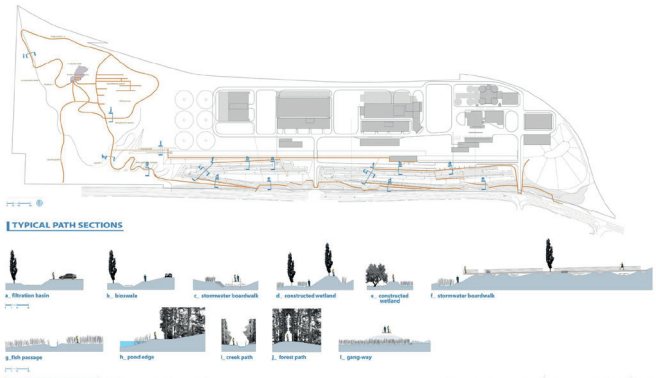
Figure 3.2- 3.6: Photos of the project, Between the waters, https://www.dezeen.com/2010/05/27/between-the-waters-by-ooze-and-marjetica-potrc/

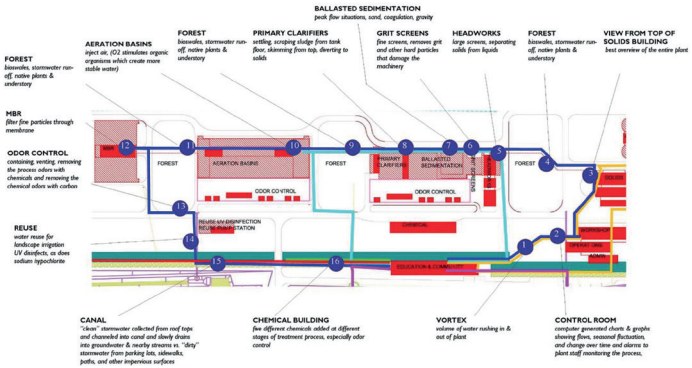
3.5 Case study:
The Brightwater Treatment

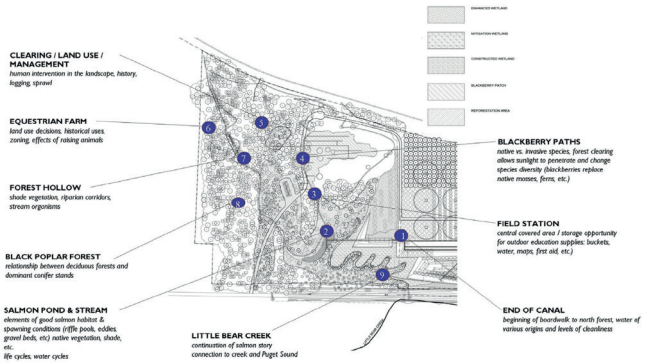












The landscape design of the wastewater treatment plant aims to create a cohesive and efficient system that integrates with the site's natural and cultural context. The constructed wetlands and forest serve as a living metaphor for the water cleansing process, utilizing the changing elevations to slow the flow of water and release clean storm water run-off into Little Bear Creek. The landscape design also incorporates the reuse of on-site soil excavated during construction.

The design approach also addresses the unique intersection of site uses, integrating the plant into the rural and industrial context while mitigating its visual impact. The expansion of existing wetlands, creeks, and forest further enhances the site's connection to the surrounding natural environment.

It incorporates three landscape systems: planting, circulation, and on-site water handling. These systems serve to integrate the industrial requirements of the plant with habitat enhancement and opportunities for public education and recreation. Overall, the landscape design of the wastewater treatment plant serves as a model for integrating infrastructure with the natural environment and promoting sustainable practices. This project provides a reference for the sustainable utilization of water and landscape renovation of sewage treatment plants in this thesis. The redesign and connection between sewage treatment facilities and natural systems, as well as the consideration of landscape effect and safety balance in trail design, are crucial in the subsequent site-specific design.

Figure 3.7- 3.12: Photos of the project, The brightwater treatment, http://www.bustersimpson.net/artplans/pdf/bustersimpson-brightwater.pdf

04 DESIGN PROPOSAL

4.1 Municipality of Matera:
from hidden water city to hidden water region



Cirluar system



Social network



Green space



Fountain



Grabiglioni



WWTP

Design by old wisdoms

In the rediscovery of Sassi di Matera from a stone city to a hidden water city, the three wisdoms are the key points to explain the internal mechanics of this organic town.

The circular system takes full advantage of the local topography and soil conditions, creating a sustainable circle of rainwater, moisture, spring water and snow. The social network is formed spontaneously based on different water works and elements, while the green space accompanied with water has improved the ecological environment. The traditional water system in Sassi di Matera shows the old wisdoms and local traditions about water, and that should not only be cherished as a cultural heritage by the future generations, but also be learnt and applied to this area as a case study.

Design for sustainable future

The circular system, social network and green space can be the link between the heritage and future. By designing from these three aspects, we strive for a more sustainable future.

Creating a new circular water system helps to solve the water shortage, wastewater pollution, and potential urban flooding problems. Building a new social network based on water elements contributes to a sense of community and identity, as well as a deeper connection to the heritage and lost traditional practices. Constructing new green space enables a complete blue-green network and diverse flora and fauna communities.

Design through different water elements

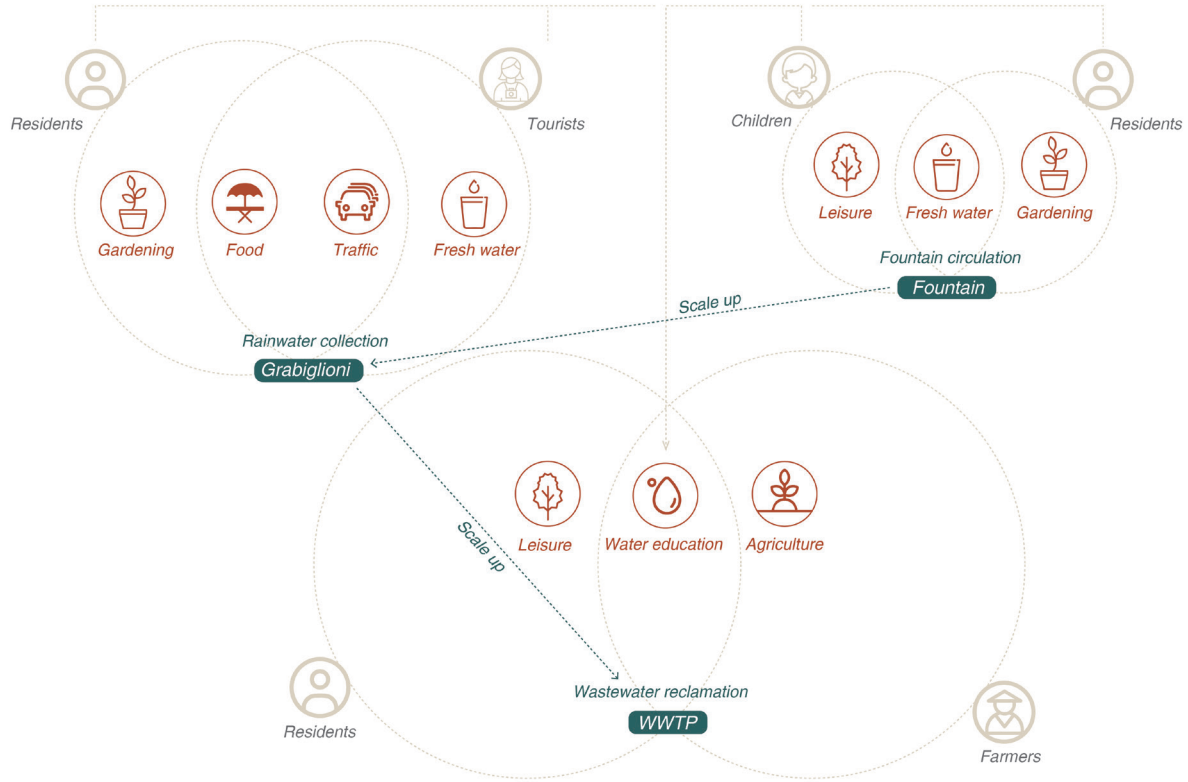
All the designs start from careful observation and discovery of the hidden water in Matera, just as all the traditions and stories started from the water system in Sassi di Matera. There are three kinds of “hidden circular water” with the circular characteristic but staying neglected by all. They are represented by three water elements, drinking water fountain, grabiglioni, and wastewater treatment plant (WWTP).

The drinking water fountain, which used to be a symbol of social life, has a small circulation from drinking water to wastewater in drains. The grabiglioni, which was the important open water course in Sassi and turned into motor traffic and underground sewers later, stands for the historical and modern circulations of water and traffic. The wastewater treatment plant, which is the representation of the modern water system striving for high efficiency and environmental disruption, has a interesting but hidden circular system for the whole city.

Analyzing these different water elements and studying their circularity will be the first step towards the spatial design, realizing the overall goal of water cycle optimization, social network construction and blue-green space integration.

Design through scales

According the water capacity of each water elements, their impacts will be different. So, my design proposals for these three elements will focus on different scales.



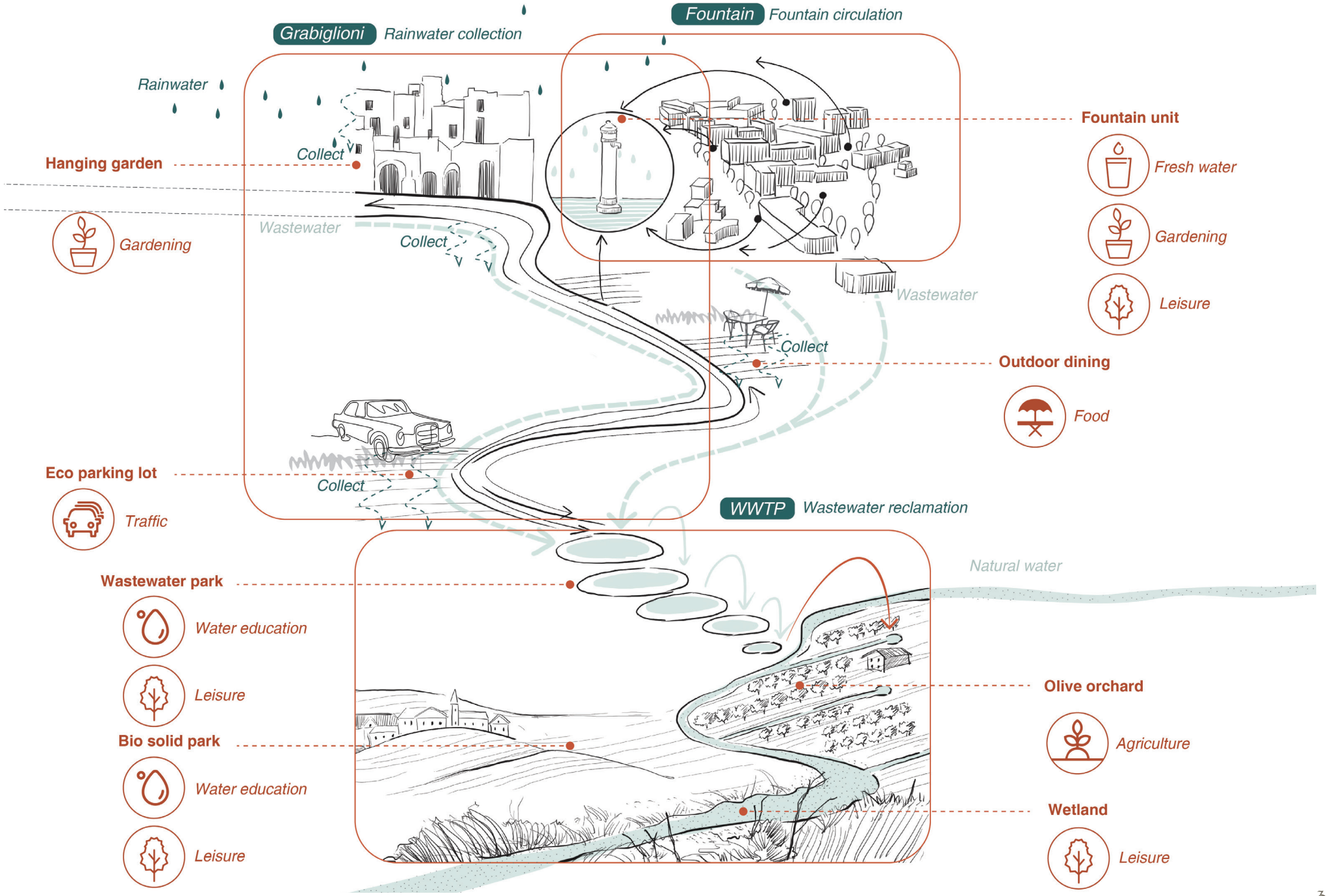
water element	circular system	scale	social network	local	visitor	green space
fountain	- reveal circularity	Local scale	link between urban & Sassi	↑↑		- build new green network
grabiglioni	- rainwater storage & connection to old system	Sassi scale	link between local & visitor	↑↑	↑↑	- cultivate green
wwtp	- wastewater purification & reclamation	Regional scale	link between rural & Sassi	↑↑↑	↑↑↑	- connect parks - increase wetland

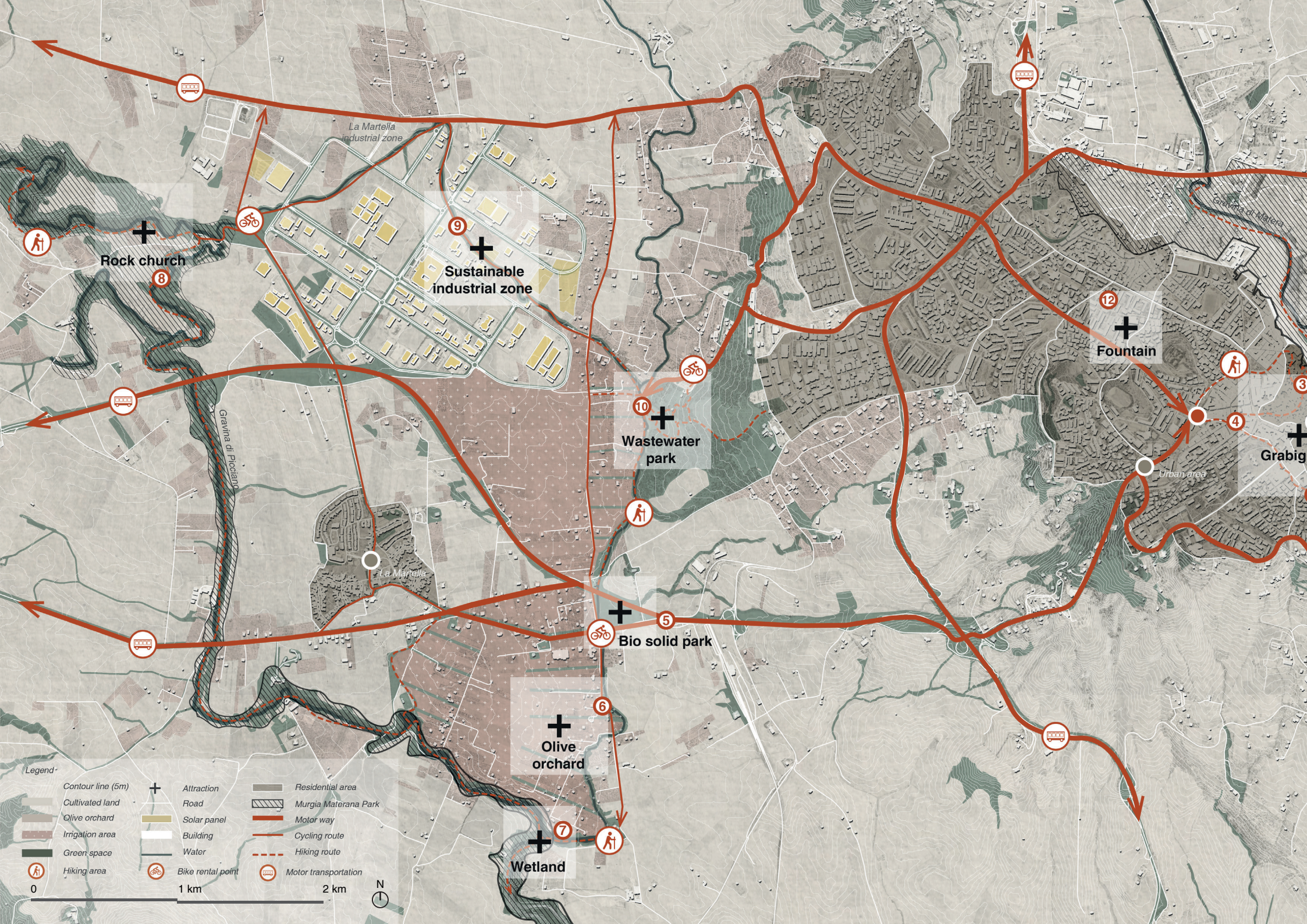
Design matrix

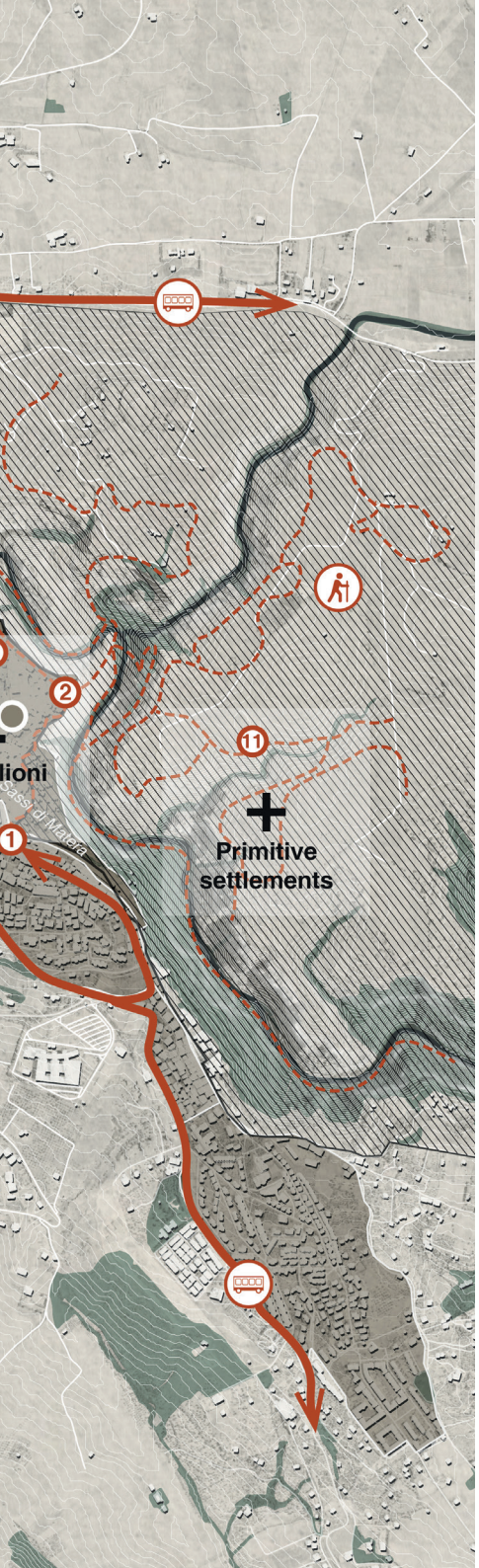
The drinking water fountain, as the most basic water unit scattered in city, has the potential of working locally as a neighbourhood unit. The grabiglioni, now a hidden memory in old Sassi, has the perfect linear form to bring everything together for showing a bigger circularity in Sassi scale. The wastewater treatment plant, with the biggest water capacity, is the most promising supply for new green spaces in this dry region, so it can contribute to the big changes in the regional scale.

Design for different user groups

Matera, as the European capital of culture, has more and more temporary residents. With increasing funds going to the growing tourist industry, the need and identity of local people have the threat of being overlooked. The design proposals focus more on the reconnection to Sassi of the local people, rather than locking Sassi in glass showcase only for the tourists. Through the design intervention, a balance will be found between local people and old Sassi, as well as between locals and tourists.


Grabiglioni
Rainwater collection
Fountain
Fountain circulation
Rainwater
Collect
Hanging garden
Gardening
Wastewater
Collect
Fountain unit
Fresh water
Gardening
Leisure
Wastewater
Collect
Outdoor dining
Food
Eco parking lot
Traffic
Collect
WWTP
Wastewater reclamation
Natural water
Wastewater park
Water education
Leisure
Olive orchard
Agriculture
Bio solid park
Water education
Leisure
Wetland
Leisure


La Martella industrial zone
Rock church
8
9
Sustainable industrial zone
10
Wastewater park
12
Fountain
Gravina di Matera
Gravina di Picciano
La Martella
Urban area
Grabig
Bio solid park
5
6
Olive orchard
7
Wetland
Legend
Contour line (5m)
Cultivated land
Olive orchard
Irrigation area
Green space
Hiking area
Attraction
Road
Solar panel
Building
Water
Bike rental point
Residential area
Murgia Materana Park
Motor way
Cycling route
Hiking route
Motor transportation
0
1 km
2 km
N



Social network - clue of story

Based on the new public space, new representations of water are preserved or created according to the landscape characteristics of different regions, serving as narrative clues for invisible water regions.







Green space - plot of story

New green spaces are created acorss the region relying on the invisible water. Rainwater, wastewater, and water from public fountains are all embodied in different landscapes













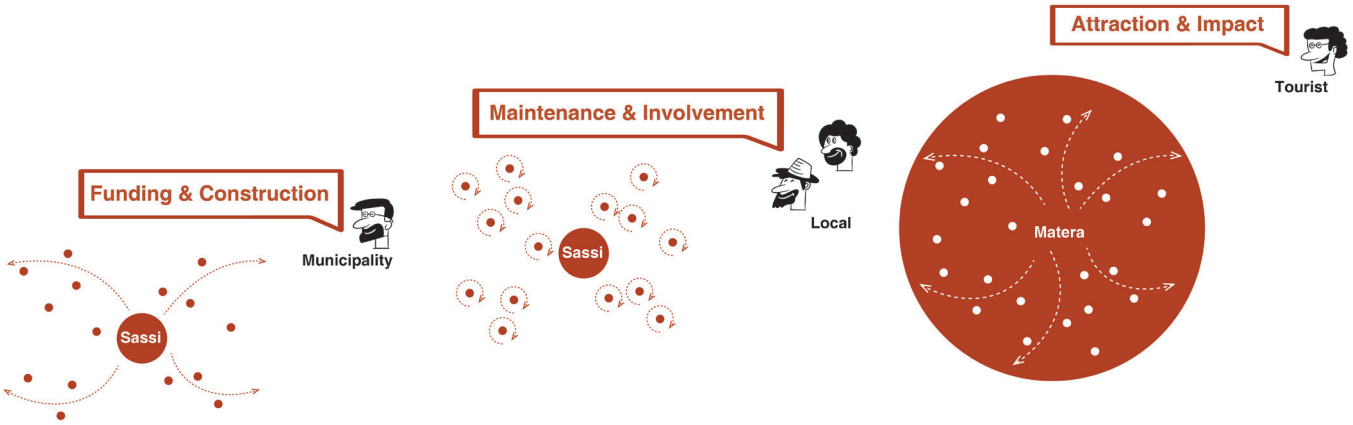


Circular system - theme of story

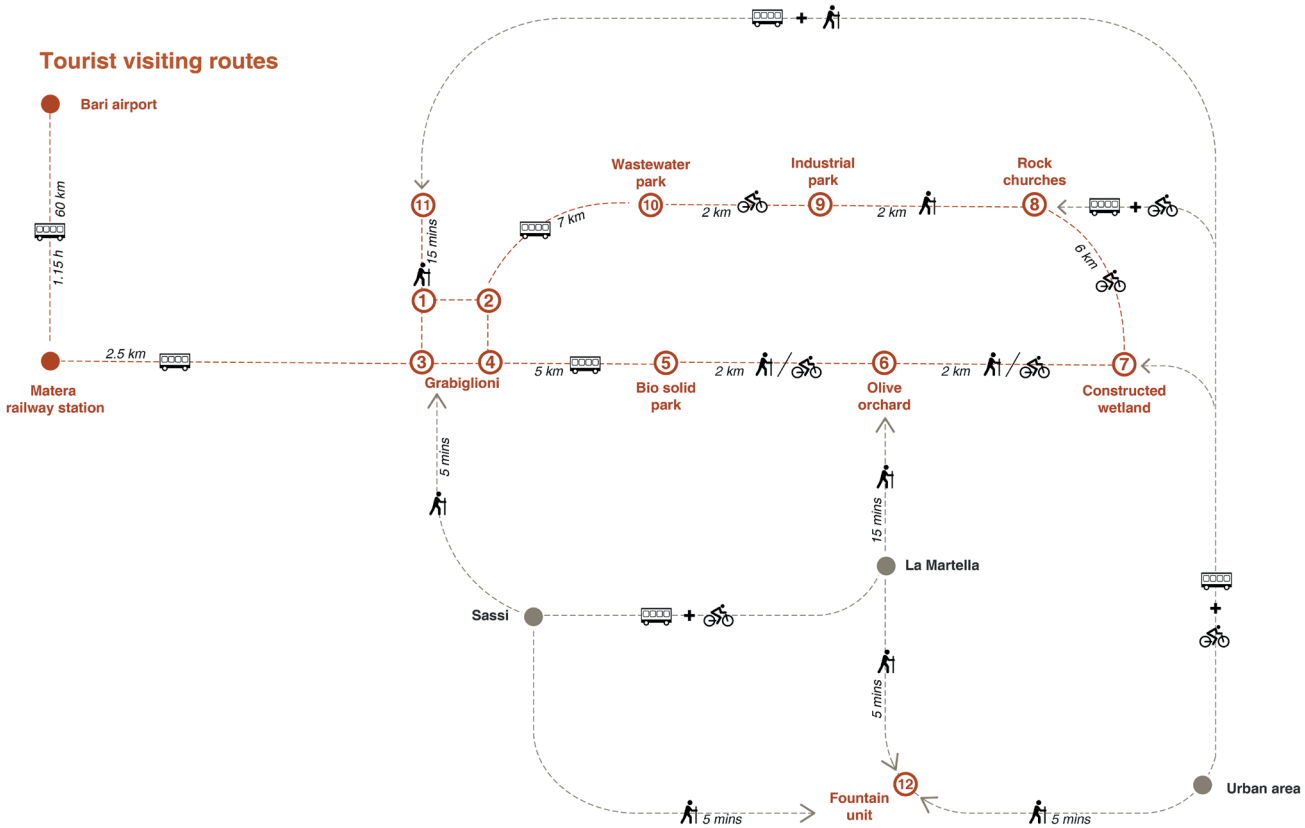
The artificial water purification process and natural water purification process have formed an organic combination in different situations, and this new circularity of wastewater brings opportunities for sustainable development in the region.







Development plan of project



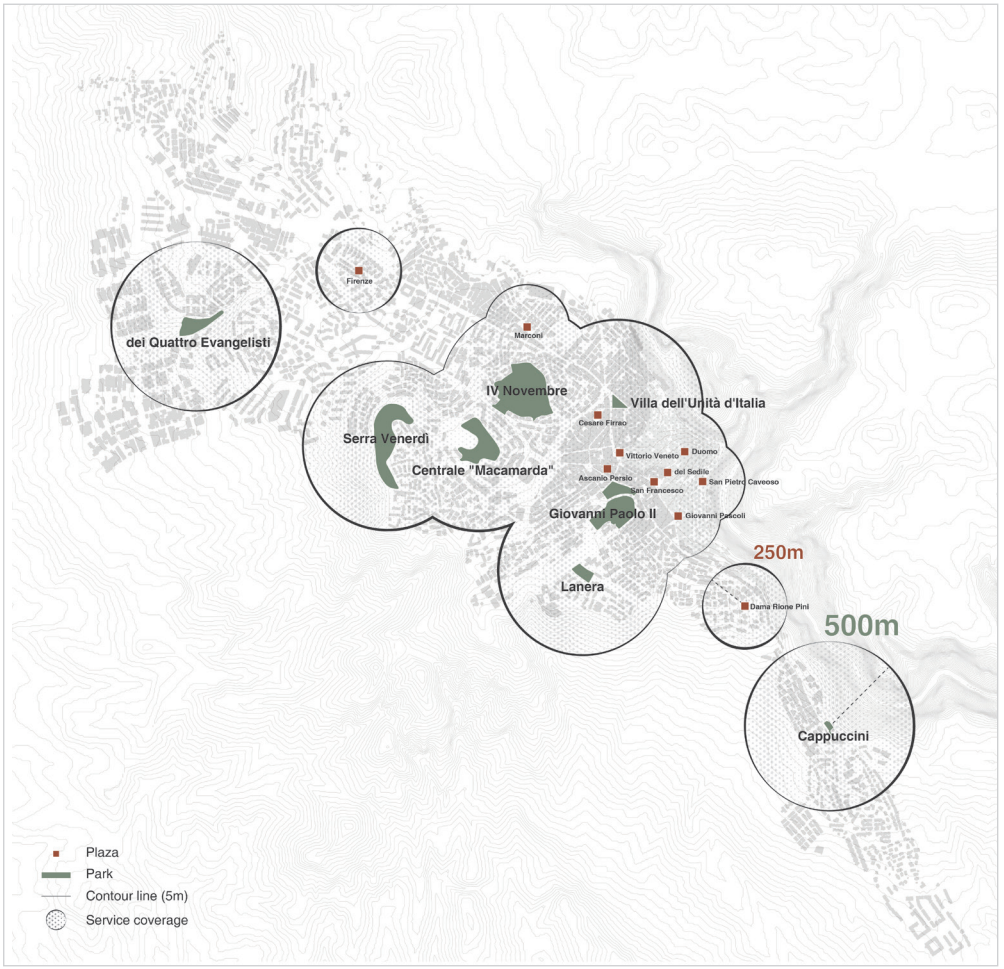
Route and traffic planning

Although the scales of the three elements (fountain, grabiglioni, and WWTP) are not the same, they can be connected through the routing system at the design scale. By exploring and designing different hidden circularities, the water resource can be used in a sustainable way, and this has become the theme of landscape narrative. The green spaces that are manifested through hidden water (natural wetlands, green patches in olive gardens, grass slopes with sewage sludge, community gardens in city...) become different parts of the narrative for people to explore. Meanwhile, in the process of landscape design, different landscape representations also become important clues in the narrative. Ultimately, the construction of these three elements in the region by the municipality and the participation and maintenance of locals will achieve the transformation from the stone city to hidden water region.

At the same time, the routing system also takes into account the needs of different users and transportation modes. Three different modes of transportation, including motorized transportation, cycling, and hiking, were designed based on different distances and landforms. The routes distributed in the region are designed for tourists, and the public space and green space with higher reachability are analyzed for local residents.

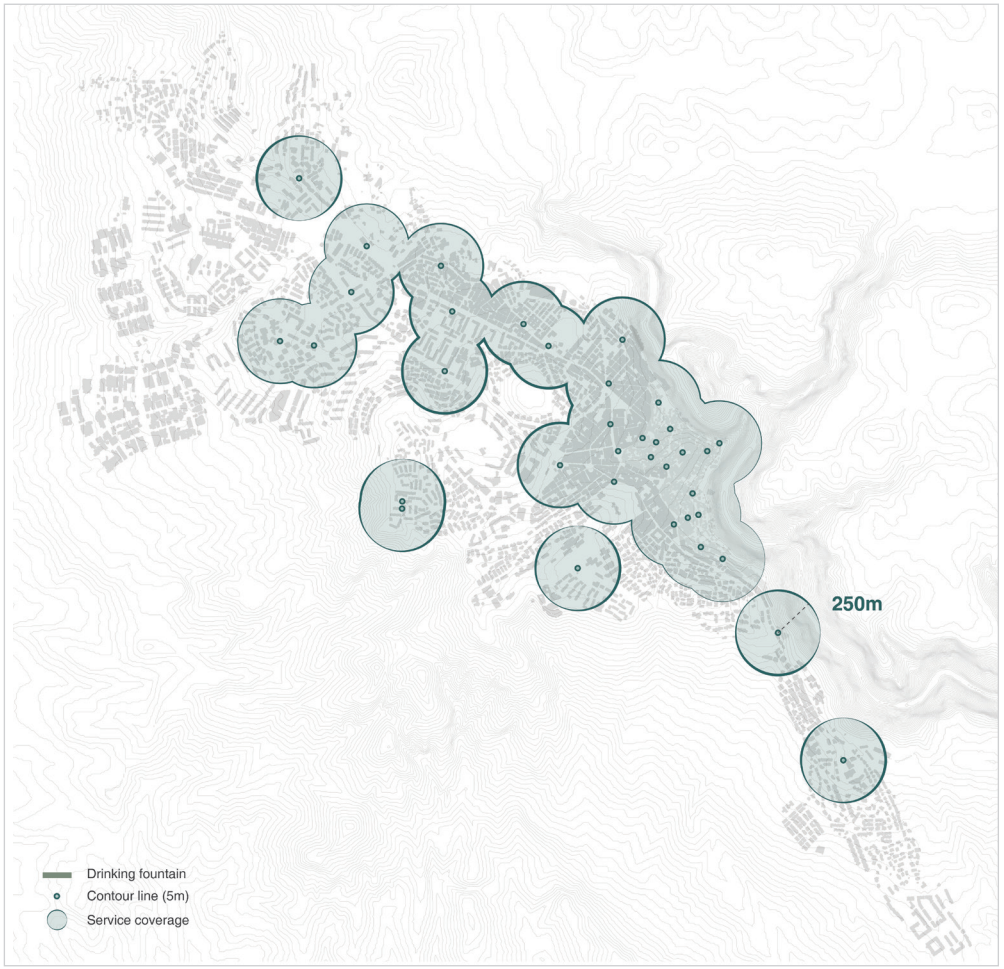


Neighbourhood and population in Matera

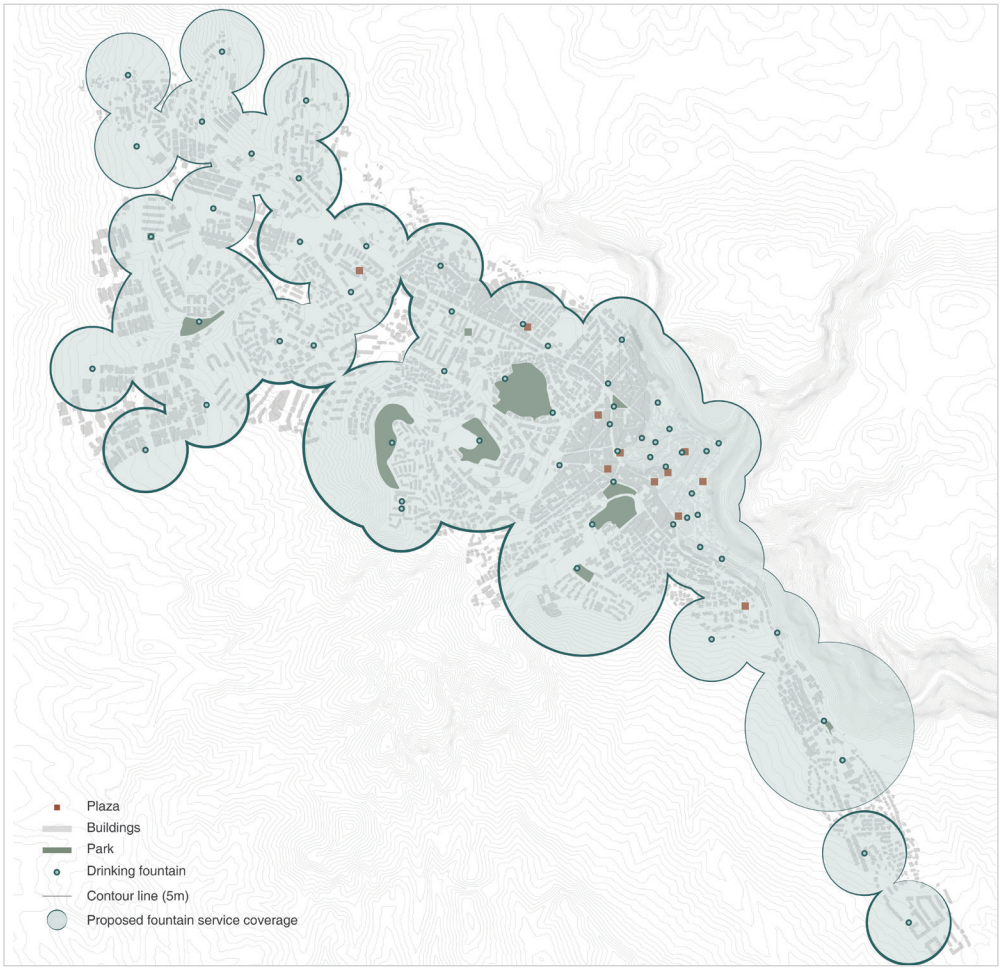


Public space and accessibility in Matera

0 500 2000m N

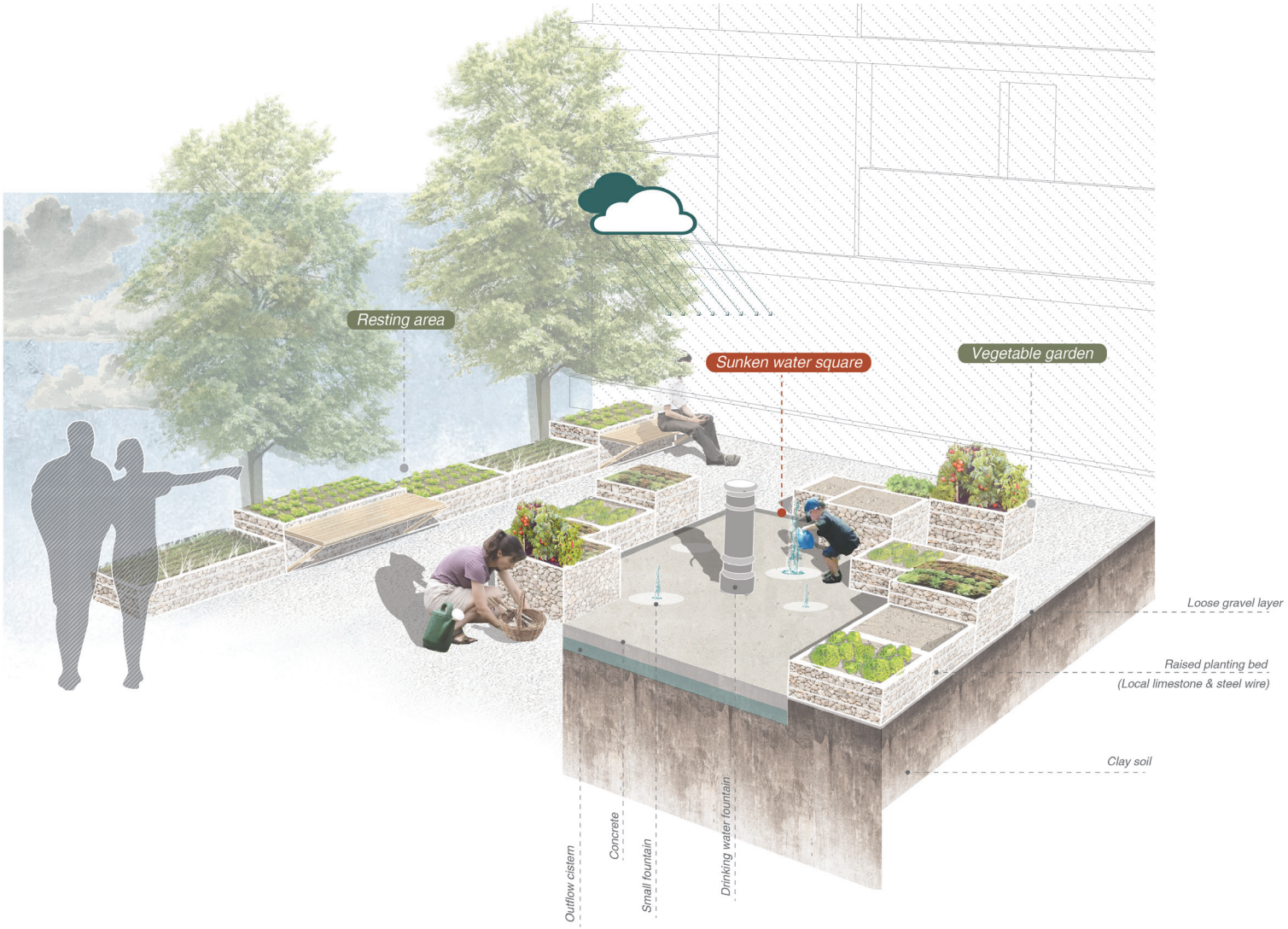


Fountain and accessibility in Matera



Proposed neighbourhood unit in Matera

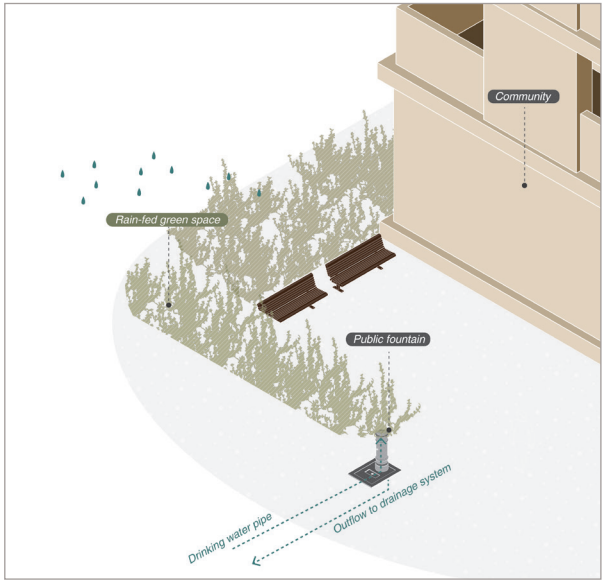
0 500 2000m N



Proposed fountain circularity in community garden

Matera is home to approximately 60,000 people, with only a small portion residing in Sassi di Matera, the popular tourist destination. The majority of the residents live in approximately 20 communities surrounding the historic city, with limited connections to the water culture of Sassi di Matera.

There is a clear divide between the old city and the new city, with public space distribution being uneven and inadequate in the surrounding communities. The quality of public life in the area needs improvement, and the almost abandoned public fountains, once a vital source of drinking water and a hub for social interaction, can be proposed as basic units of a tighter network of public spaces to serve city dwellers. The fountains can be transformed into water sources for irrigating community gardens, and a more accessible public space network can be established based on the theory of neighborhood unit and the five-minute walk.



Current fountain unit in neighbourhood



Figure 4.1



Figure 4.2

The grabiglioni were known as open-air channels that were historically used to manage stormwater and wastewater in urban areas. However, at the very beginning, it was originally a naturally formed waterway, but later it became a residential area with people building houses around it. The two residential centers, Sasso Barisano and Sasso Caveoso, are located around grabiglioni.

As cities grew and became more densely populated, the grabiglioni became less effective and sometimes even contributed to pollution and disease. To address these issues, many grabiglioni were eventually covered over with pavement or other materials to create underground sewer systems. This process of covering over grabiglioni took place over several decades, with the last works being carried out in the 1920s and 1930s. The Fascist regime in Italy also oversaw some of these efforts to modernize urban infrastructure and improve public health.

Today, grabiglioni has lost its original significance as a social and water center of the city, and its historical importance is often forgotten. The hard paving of the surrounding areas has turned it into a transportation hub for motor vehicles, serving as the only means of transportation for the Sassi di Matera.

Figure 4.1: Fosso Caveoso with highlighted grabiglioni in 1920, from the book, Appunti di Matera Sotterranea 2. Grabiglioni, Fosso Barisano, Fosso Caveoso.
Figure 4.2: Fosso Barisano with highlighted grabiglioni in 1920, from the book, Appunti di Matera Sotterranea 2. Grabiglioni, Fosso Barisano, Fosso Caveoso.

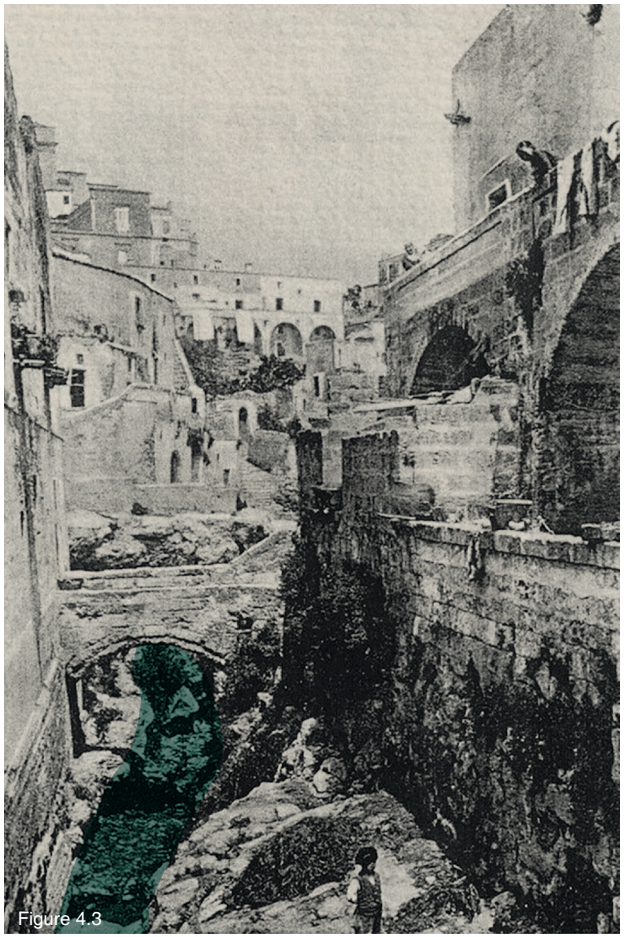


Figure 4.3


Figure 4.4

The transformation from a water-oriented city to a traffic-oriented urban space organization, on the one hand, enhances the accessibility of Sassi di Matera, serving a large number of residents and tourists; on the other hand, the lack of green spaces has created problems with urban waterlogging during periods of heavy rainfall, as evidenced by a 2018 disaster caused by poor drainage. Reorganizing the space around grabiglioni is now a research topic to achieve balance in all aspects.

By analyzing the past and present space types, forms, circular systems, green spaces, users, and social impacts related to grabiglioni, the aim is to rethink its spatial organization and functional connections. The ultimate goal is to minimize renovation costs while addressing issues of rainwater accumulation and loss of water history, thereby transforming grabiglioni into a water and social center once again, connecting both local residents and tourists.

Figure 4.3: Grabiglione di via Fiorentini in 1900, http://www.muvmatera.it/aspFoto/scheda-detail.asp?id=2658
Figure 4.4: Covered grabiglione di via Fiorentini in 2004, http://www.muvmatera.it/aspFoto/scheda-detail.asp?id=2658

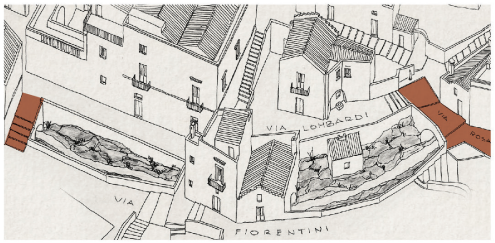
0 *Sewer*



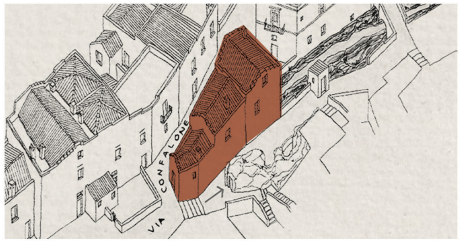
1 *Sidewalk*



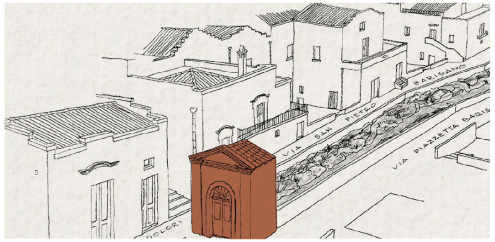
2 *Bridge*



3 *Lamione*



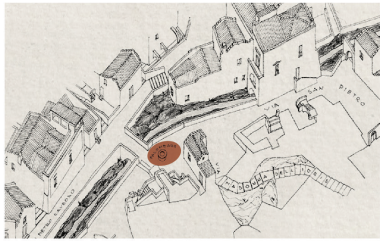
4 *Chapel*



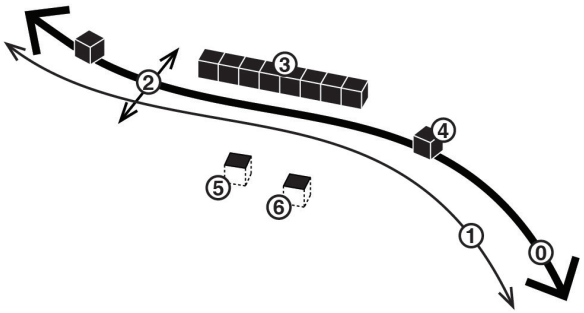
5 *Cistern*

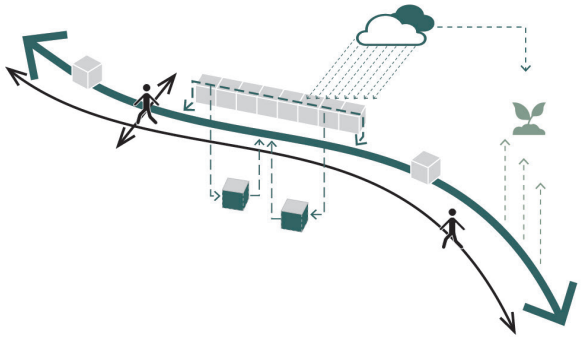


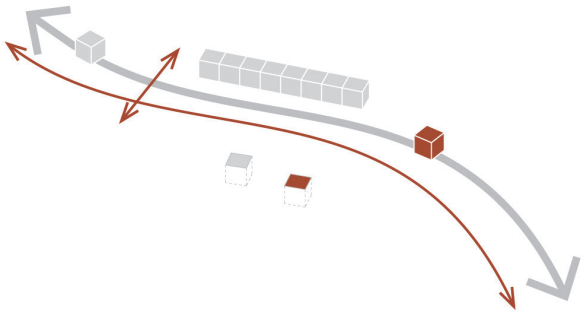
6 *Palombaro*



Grabiglioni in 1910:
Circular water & social life





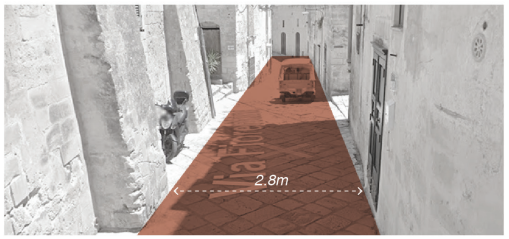


Type	Relation	Form	Circular system	Green space	Social network	User
⓪ Grabiglioni	×	Line	Drainage	Humus provider	×	Public
① Sidewalk	Along	Line	Pedestrian traffic	×	Main street	Public
② Bridge	Above	Line	Pedestrian traffic	×	Main crossing	Public
③ Lamione	Along	Line	Rainwater collection	×	×	Private
④ Chapel	Above	Block	Rainwater collection	×	Religious site	Public
⑤ Cistern	Near (below)	Block	Rainwater storage	×	×	Private
⑥ Palombaro	Near (below)	Block	Rainwater storage	×	Plaza	Public

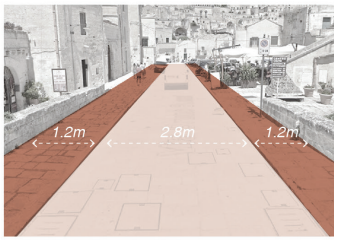
0 *Underground sewer*



1 *Car lane*



2 *Sidewalk*



3 *Lamione*



4 *Parking lot*



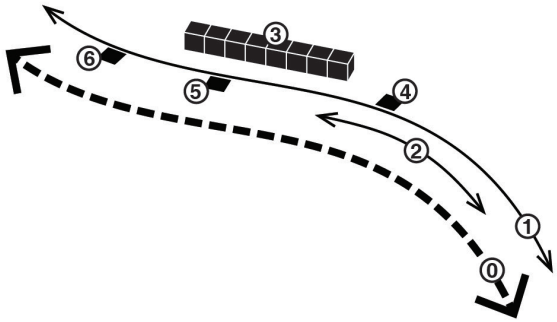
5 *Outdoor dining*

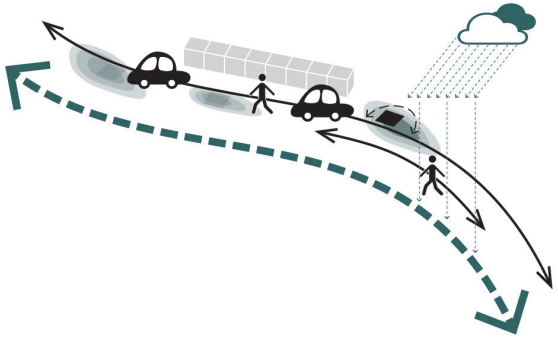


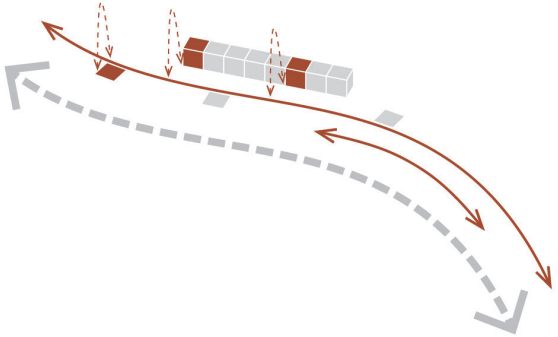
6 *Fountain*



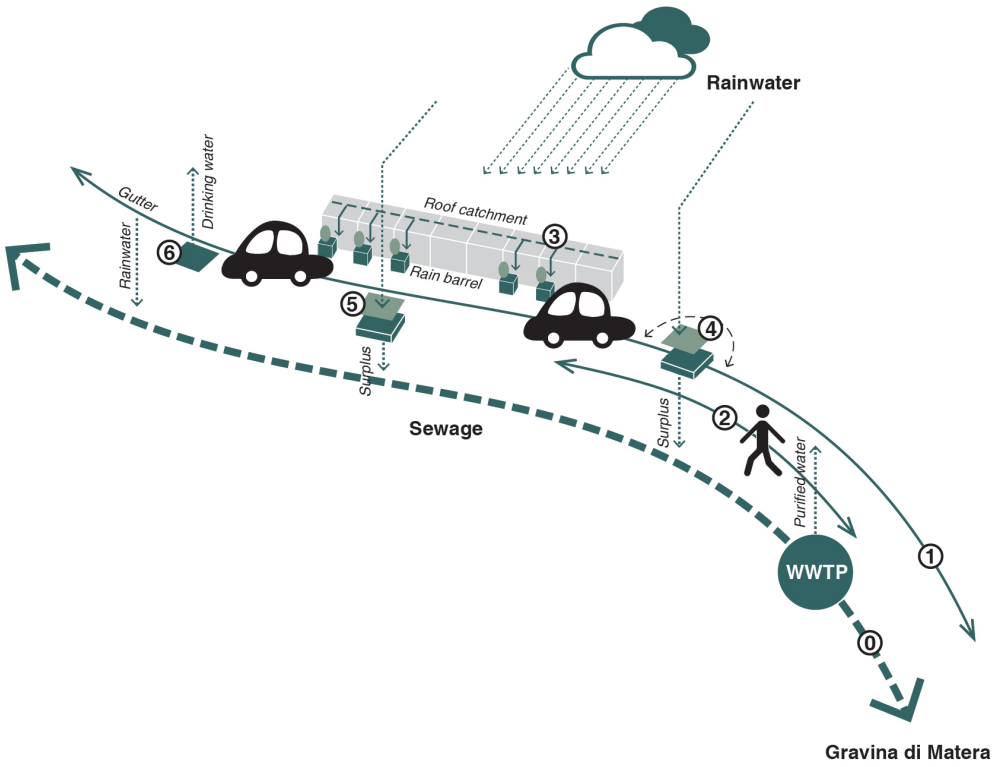
Grabiglioni in 2023:
Traffic & tourist center

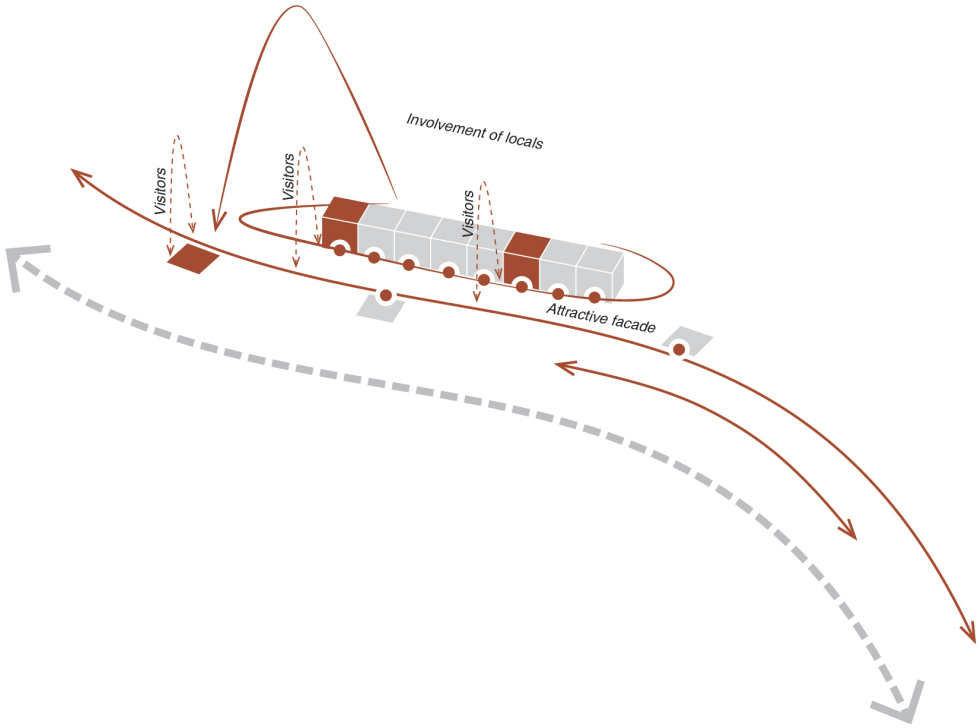






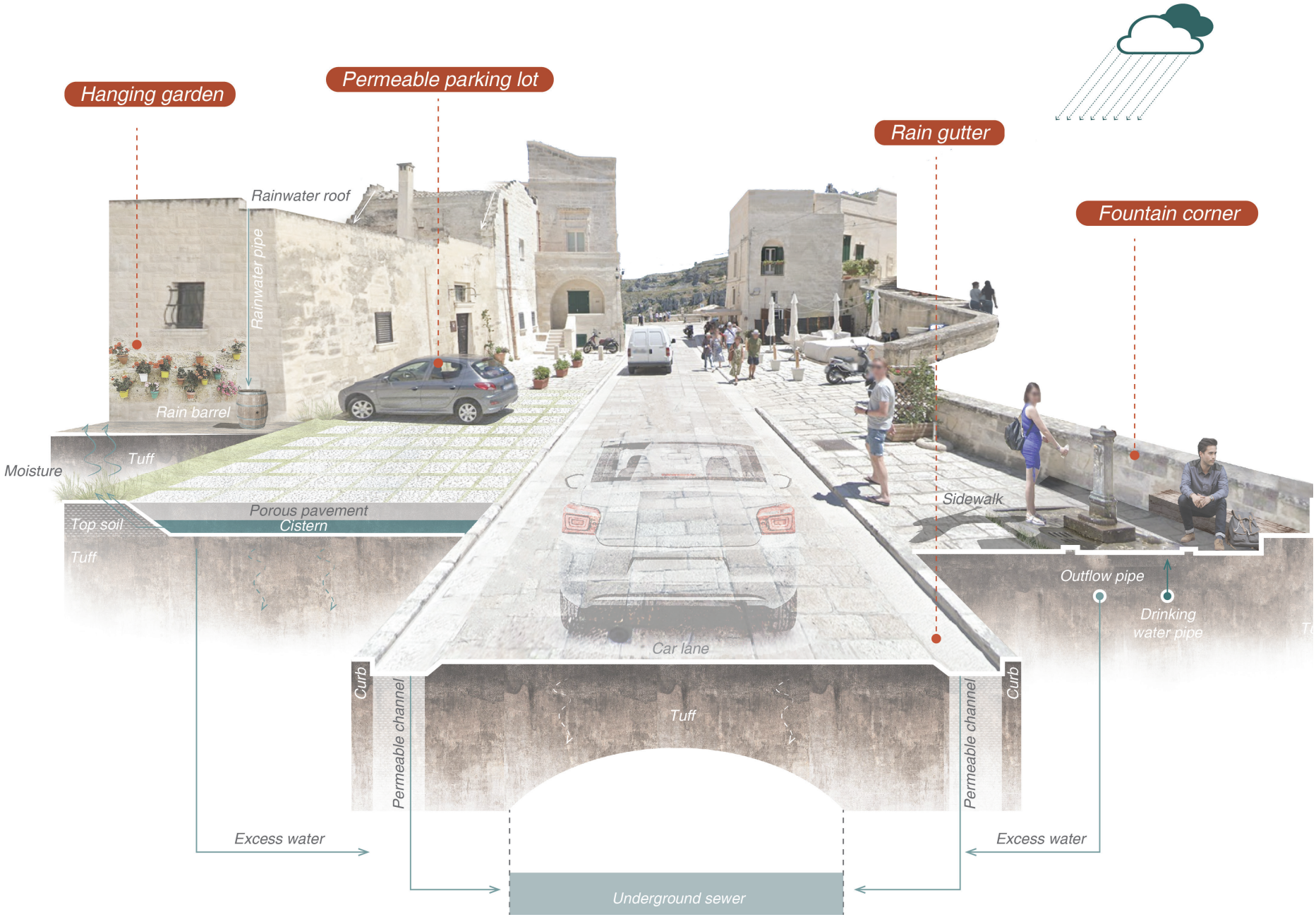
Type	Relation	Form	Circular system	Green space	Social network	User
⓪ Grabiglioni	×	Line	Hidden drainage	×	×	Public facilities
① Car lane	Along (above)	Line	Only motorway	×	Main street	Public facilities
② Sidewalk	Along (above)	Line	Pedestrian traffic	×	Main street	Public facilities
③ Lamione	Along (above)	Block	×	×	Residential or service	Locals
④ Parking lot	Near (above)	Surface	Parking space	×	×	Public facilities
⑤ Outdoor dining	Near (above)	Surface	×	×	×	Locals & visitors
⑥ Fountain corner	Near (above)	Surface	×	×	Water sharing and resting	Visitors

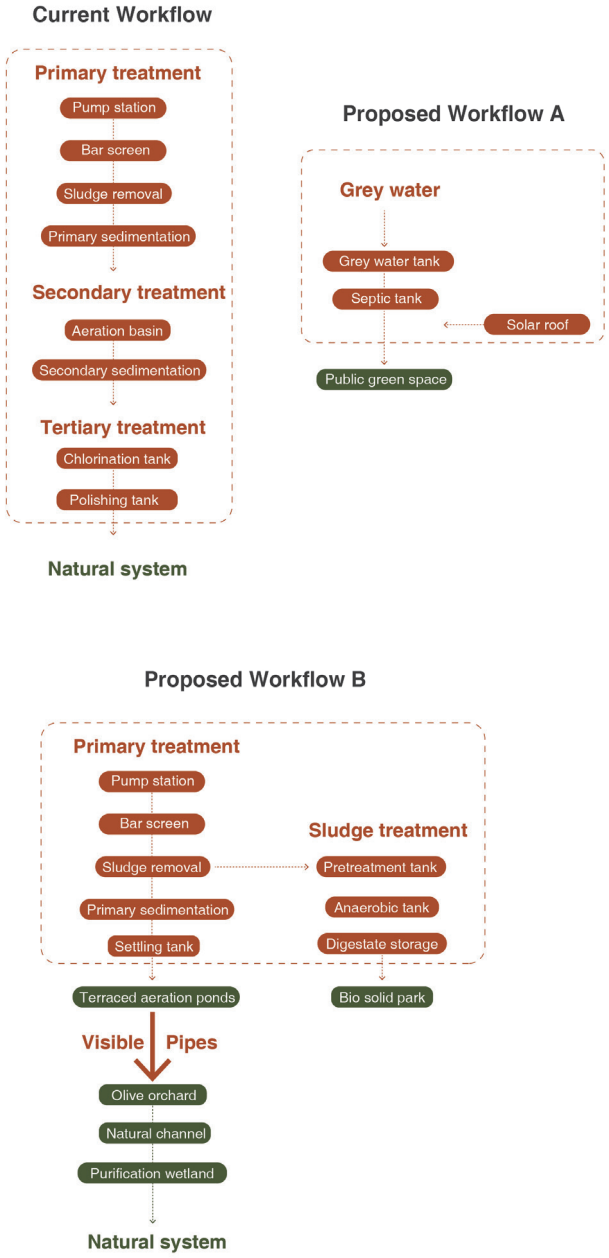




Proposed Grabiglioni:
from traffic-oriented to water-oriented

Type	Circular system	Green space	Social network	User
⓪ Grabiglioni	Hidden drainage	×	×	Public facilities
① Car lane (with gutter)	Rainwater evacuation	×	Main street	Public facilities
② Sidewalk (with gutter)	Rainwater evacuation	×	Main street	Public faciloities
③ Lamione (with mini garden)	Rainwater collection	Mini garden	Residential or service	Locals & visitors
④ Eco parking lot	Rainwater collection	Linear green space	×	Public facilities
⑤ Garden dining room	Rainwater collection	Linear green space	×	Locals & visitors
⑥ Fountain square	Small circulation	×	Water sharing and resting	Locals & visitors


Hanging garden
Permeable parking lot
Rain gutter
Fountain corner
Rainwater roof
Rainwater pipe
Rain barrel
Moisture
Tuff
Top soil
Porous pavement
Cistern
Tuff
Car lane
Sidewalk
Outflow pipe
Drinking water pipe
Curb
Permeable channel
Tuff
Permeable channel
Curb
Excess water
Excess water
Underground sewer



There are two primary approaches to planning water and wastewater treatment systems in water management:
A: Large-scale plants that serve large municipal or regional service regions characterize centralized treatment.
B: Smaller facilities are positioned close to the water source or treatment demand, serving a more localised area in decentralized treatment.

Centralized wastewater system
Centralized desalination or wastewater treatment plants, which are large in scale and use extensive collection and distribution networks, can treat water at a lower cost by taking advantage of economies of scale. However, while these large-scale infrastructure projects can provide a significant capacity, they are not as scalable or resilient compared to other solutions.

In the municipality of Matera, the wastewater is always dealt with a centralized system. The surface water bodies object of present study, which cross a semi-dry climate area, show a stream-like regime, characterised by sudden floods due to short and intense rainfalls. In the long dry periods, the flow is mainly made up of the point sources produced in the urban and industrial areas.

Decentralized wastewater system
Decentralized treatment refers to the process of treating water or wastewater at the location where it is used or produced, instead of relying on large-scale treatment plants that require extensive distribution networks. This approach is more flexible and sustainable in the long run, as it avoids the need for expensive infrastructure to transport water over long distances.

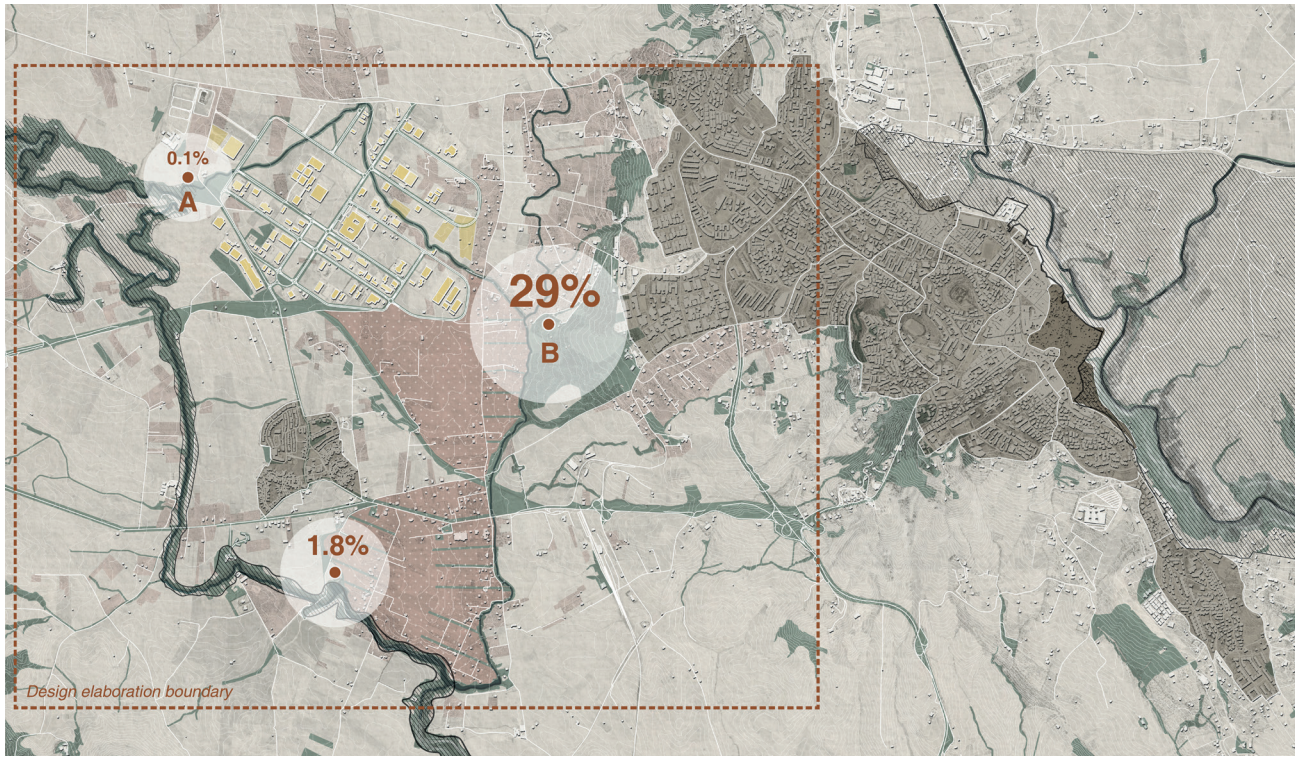
For the small wastewater treatment plants which deals with less than 1% of water, the application of decentralized wastewater system can help people build a more sustainable water cycle and use water more efficiently.

Ecological wastewater system
In order to break down biological and chemical waste in sewage, all treatment plants rely on living organisms. Conventional treatment plants use concentrated bacteria to partially decompose waste through a series of aerated pools. Chemicals are then used to remove sludge and disinfect the remaining wastewater.

Ecological wastewater treatment plants operate in a similar way, but instead utilize a diverse range of ecosystems with a variety of organisms such as algae, aquatic and marsh plants, worms, crustaceans, mollusks, and vertebrates to support bacterial populations that break down waste and remove nutrients from the wastewater.

Wastewater reclamation is a critical aspect of developing a sustainable water system. Treated wastewater can be reused in industries, to recharge aquifers, in agriculture, and to restore natural ecosystems like wetlands.

In the case of WWTP Sarra in Matera, the mechanical and biological treatment of wastewater can be partly replaced by a more ecological approach, and the nearby olive orchards can benefit from the nutrients in the wastewater. The secluded wastewater treatment process can be transformed into a more sustainable process, inviting people to appreciate, join, and learn from.



Zoom-in design boundary of wastewater circularity

In the subsequent design of wastewater, I selected the three wastewater treatment plants shown in the left figure (WWTP Sarra with the capacity of 29% wastewater in municipality, WWTP La Martella with the capacity of 1.8%, and WWTP La Martella Localita Cipolla with the capacity of 0.1%) to realize the sustainable use of wastewater.

For WWTP Sarra, due to its large-scale sewage treatment and proximity to many olive groves, there is potential to use pre-treated sewage for agricultural irrigation on a larger scale to address the problem of water shortage under the impact of climate change. At the same time, this wastewater treatment plant is located at the junction of urban and rural areas, with convenient transportation and good nearby landscape conditions, making it suitable for creating a wastewater park to show an ecological treatment process. Not only can the wastewater itself be recycled and reused, but the sludge from the wastewater also has important utilization value. The bio solids formed by the dried sludge can be used for soil improvement, agricultural fertilizers, or landscape topography. For WWTP La Martella, because it only handles a small amount of domestic wastewater from the La Martella village, only minor interventions are carried out to strengthen downstream wetlands to ensure that the treated wastewater has minimal impact on the natural water system. WWTP Localita Cipolla is a sewage plant located in a light industrial area with very small capacity. Considering its transformation into a semi-decentralized wastewater treatment system, grey water can be treated on site, and a water storage and green irrigation system can be established in conjunction with the utilization of solar energy resources, transforming the light industrial area into a more sustainable and greener space.


Cripta del Falco
Cripta del Cristo
San Nicola al Birmigiglio
Chiesa del Casale del Cristo
Chiesa rupestre San Giacinto
Cripta delle Croci
Provincial Road SP6 (Speed 50)
La Martella Localita Cipolla
La Martella industrial zone
Matera 2000
Murgia Materana Park
Zona PAIP
Sarra
Highway SS655 (Speed 60)
Gravina di Picciano
Village La Martella
Provincial Road SP8 (Speed 30)
La Martella
Current plan
Legend
WWTP
Contour line (5m)
Cultivated land
Olive orchard
Green space
Stone church
Road
Solar panel
Building
Water
0
200
800 m
N

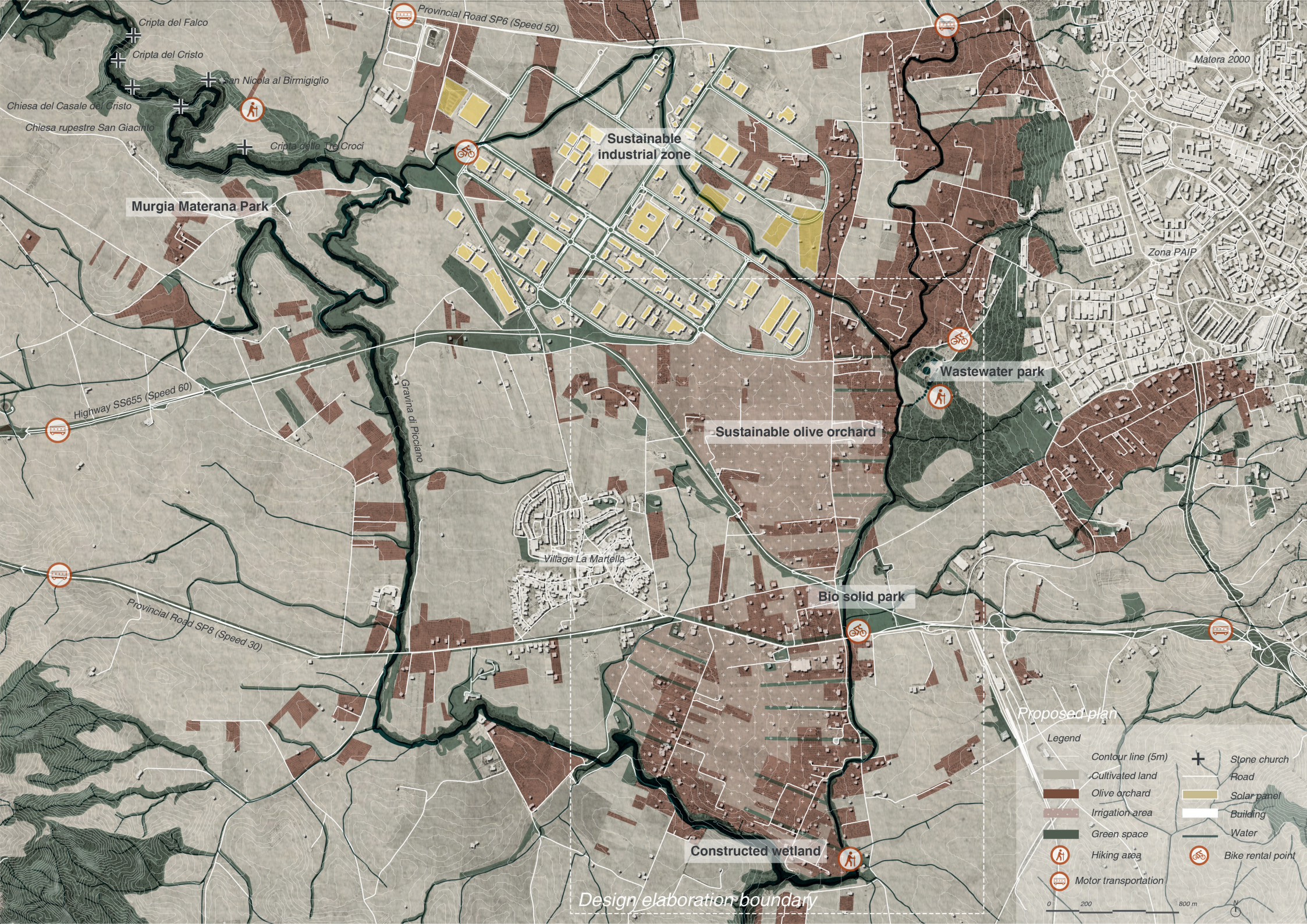

Cripta del Falco
Cripta del Cristo
San Nicola al Birmigiglio
Chiesa del Casale del Cristo
Chiesa rupestre San Giacinto
Cripta delle Tre Croci
Murgia Materana Park
Provincial Road SP6 (Speed 50)
Sustainable industrial zone
Matera 2000
Zona PAIP
Wastewater park
Highway SS655 (Speed 60)
Gravina di Picciano
Sustainable olive orchard
Village La Martella
Bio solid park
Provincial Road SP8 (Speed 30)
Constructed wetland
Design elaboration boundary
Proposed plan
Legend
Contour line (5m)
Cultivated land
Olive orchard
Irrigation area
Green space
Hiking area
Motor transportation
Stone church
Road
Solar panel
Building
Water
Bike rental point
0
200
800 m
N



Figure 5.4

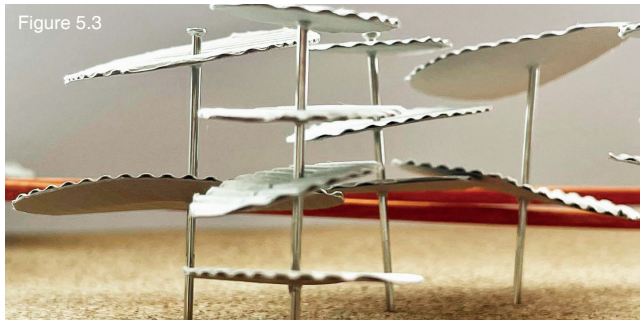


Figure 5.3

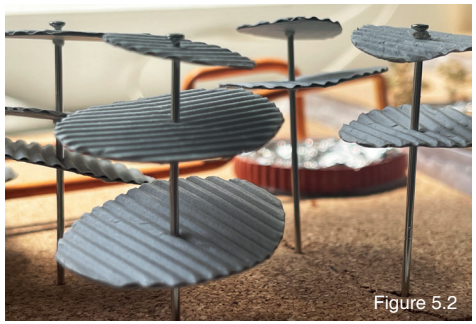


Figure 5.2



Figure 5.1



Figure 5.5

05 DESIGN ELABORATION

5.1 Representation of water: colour & form

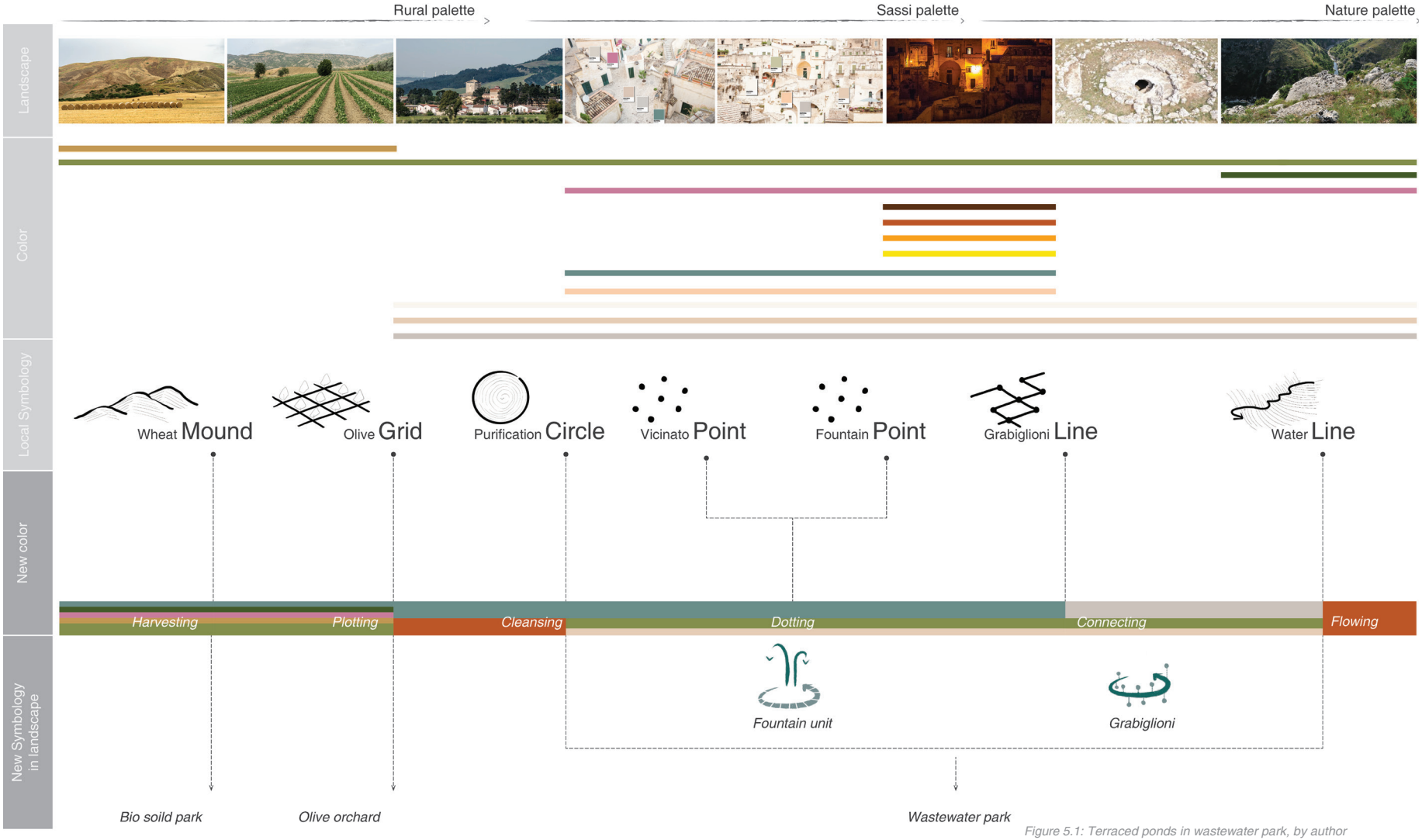
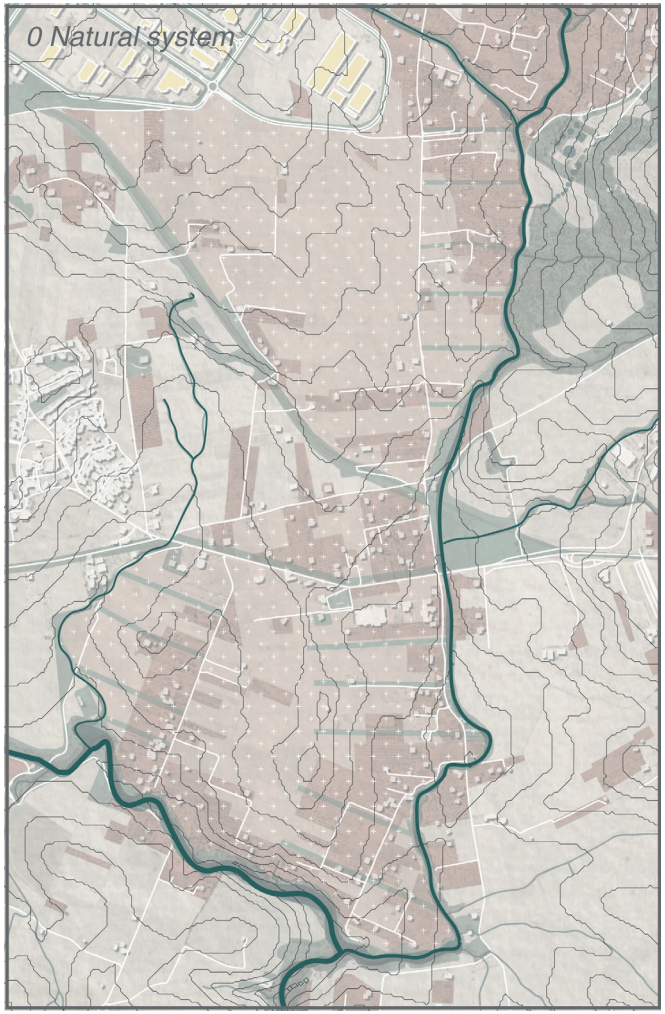
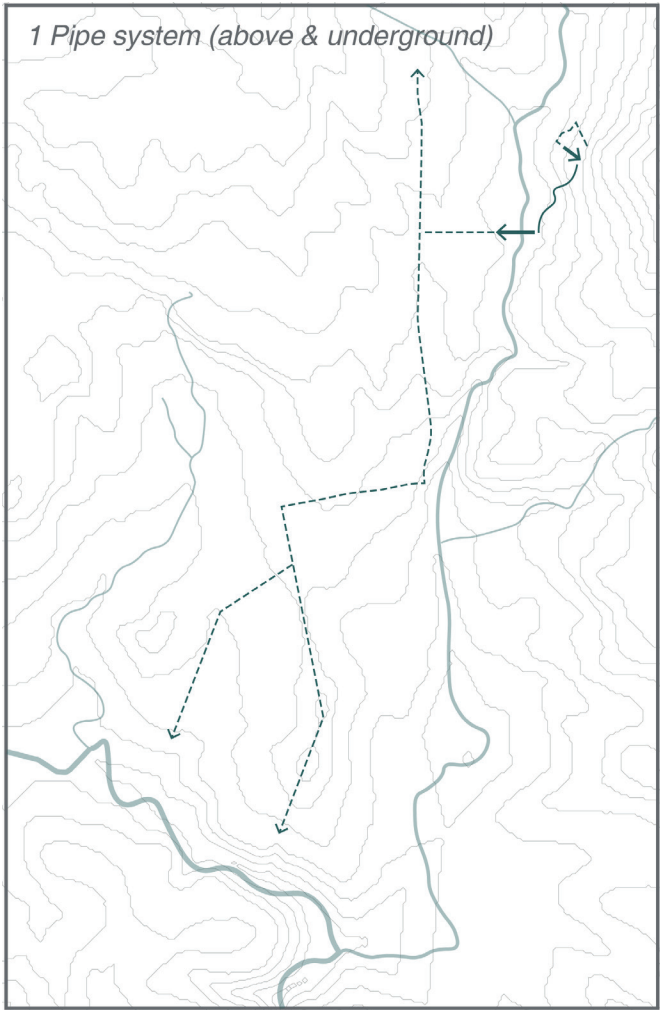


Figure 5.1: Terraced ponds in wastewater park, by author
Figure 5.2: Wastewater tank in wastewater park, by author
Figure 5.3: Wastewater pipe in wastewater park, by author
Figure 5.4: Between wastewater park and olive orchards, by author
Figure 5.5: Rainwater tank in wastewater park, by author



Contour line (5m)

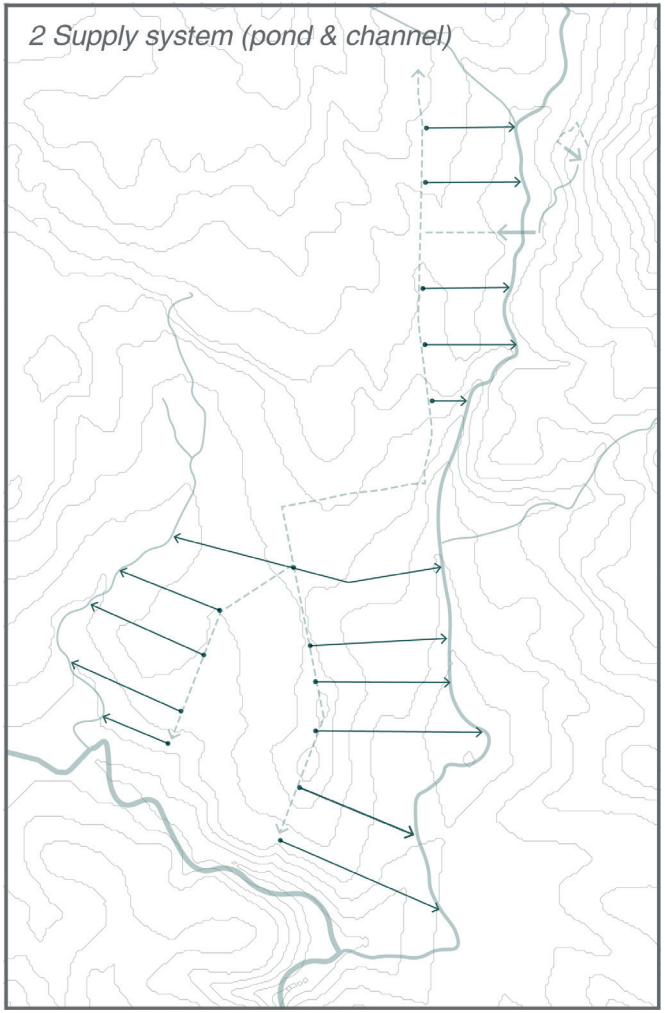
Natural water system



Underground pipes

Visible construction

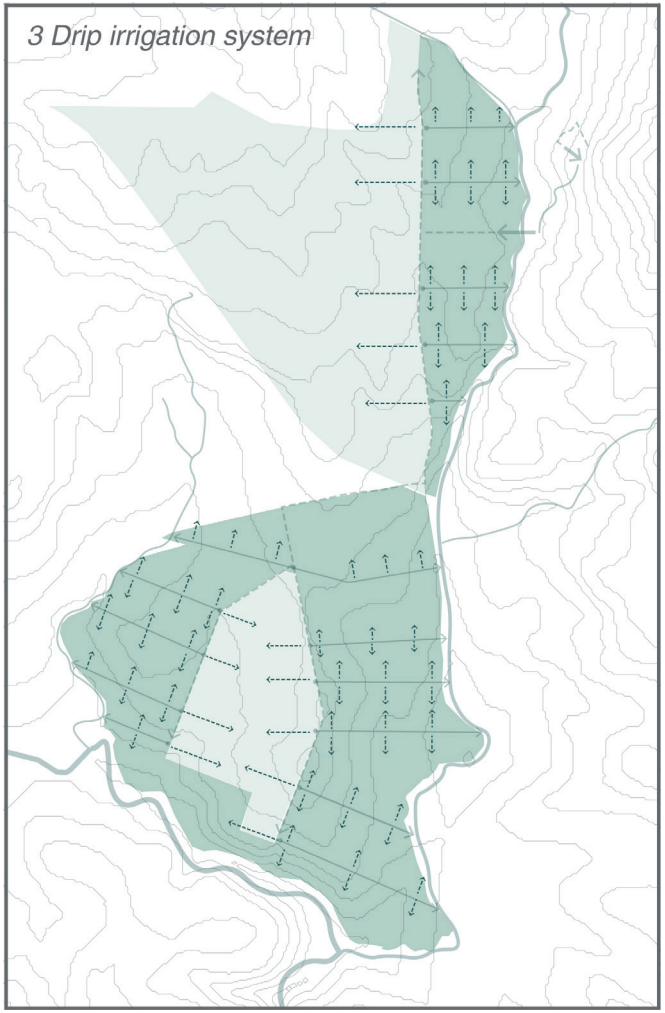
Terraced pond

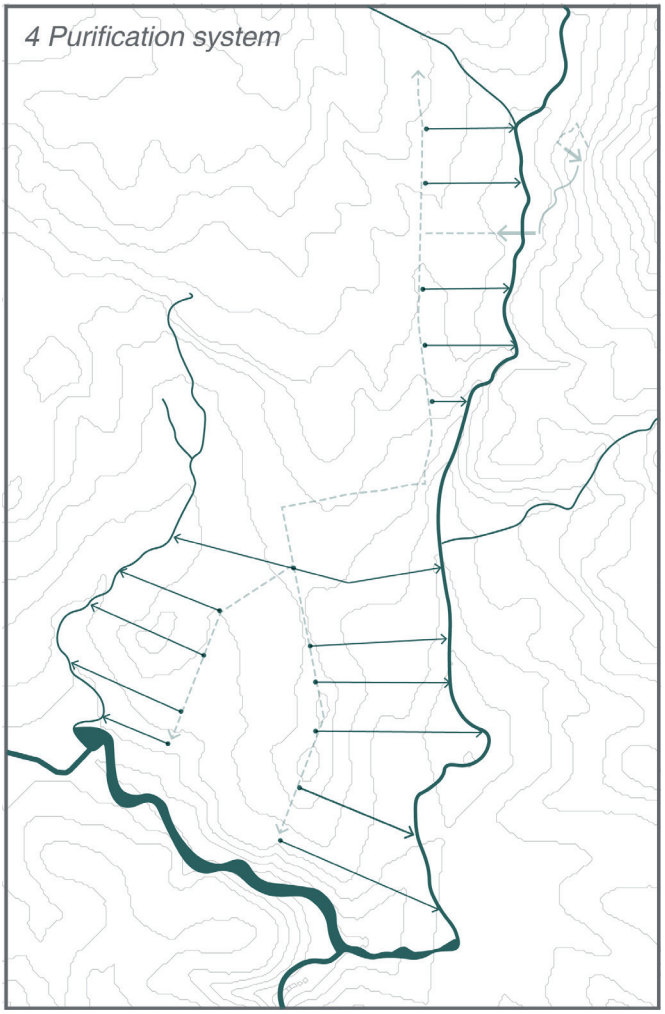


Release pond

Water channel

5.2 Water circulation



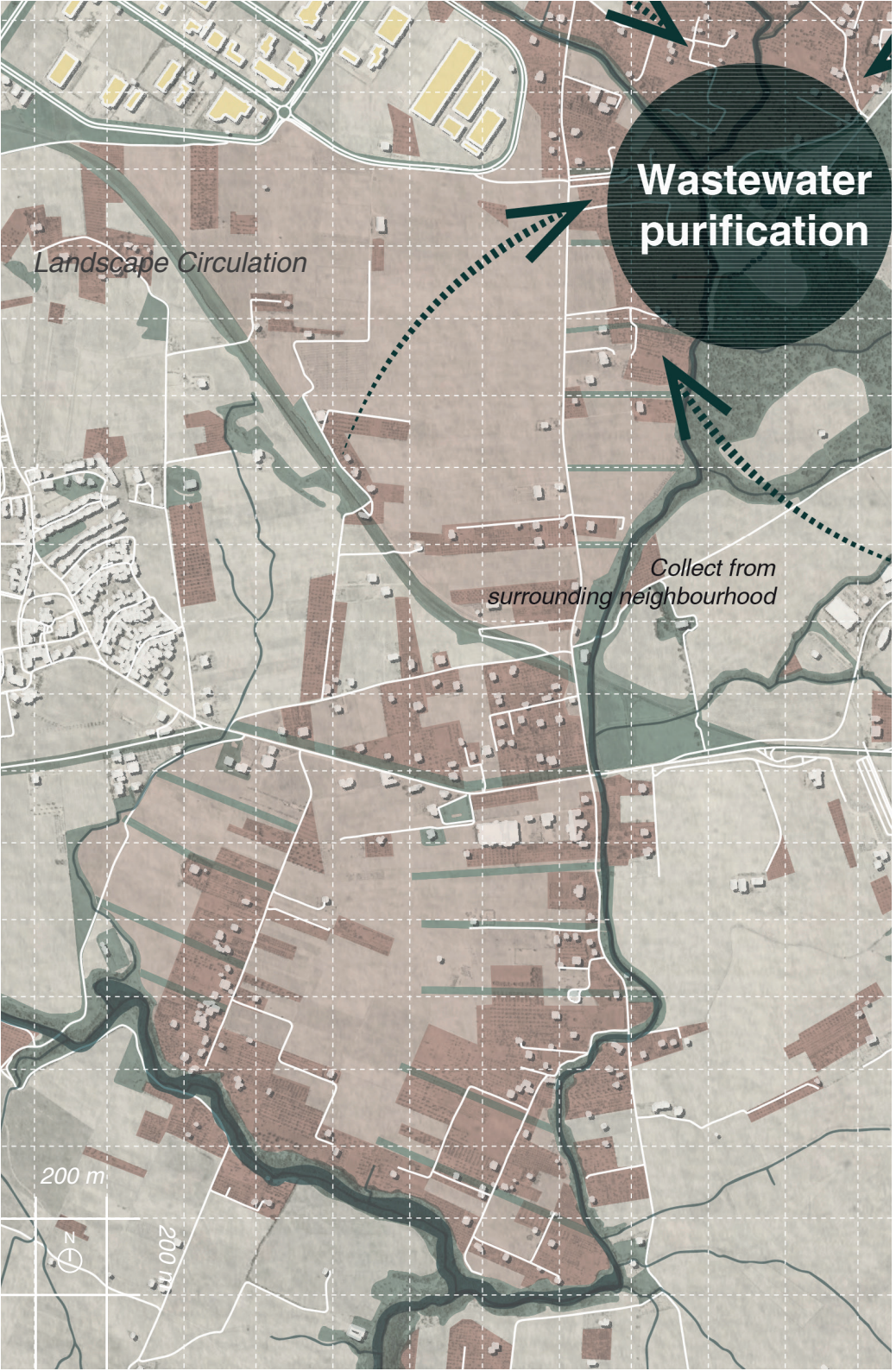


Designed area for irrigation
Possible expansion
Drip irrigation option

Expanded wetland

In the new wastewater circulation, artificial treatment facilities, ecological treatment system, artificial irrigation system, and natural water system together ensure the safety, efficiency, and ecological friendliness of the circulation.

First, after the mechanical treatment at the WWTP Sarra, the wastewater enters the newly designed ecological treatment process, and then is transported through an aboveground pipeline to the olive area on the opposite side of the stream, before entering an underground pipeline to maintain low evaporation rates. The pre-treated wastewater in the regional underground pipe system will be released in ponds located approximately every 200 meters, and then flow into the natural water system through small channels along the natural topography. These channels provide irrigation water rich in nutrients for the existing small-scale olive groves in the covered area, and farmers can connect their drip irrigation systems according to their needs. At the same time, the scattered ponds also provide the possibility of future irrigation for the surrounding areas. The wastewater not used for irrigation will be concentrated and purified in the wetland located on the south side, and tested to ensure the safety of the water flowing into the downstream Bradano River.



5.3 Wastewater purification: sustainable wastewater park

Landscape Representation



natural Pond



Artificial Tank



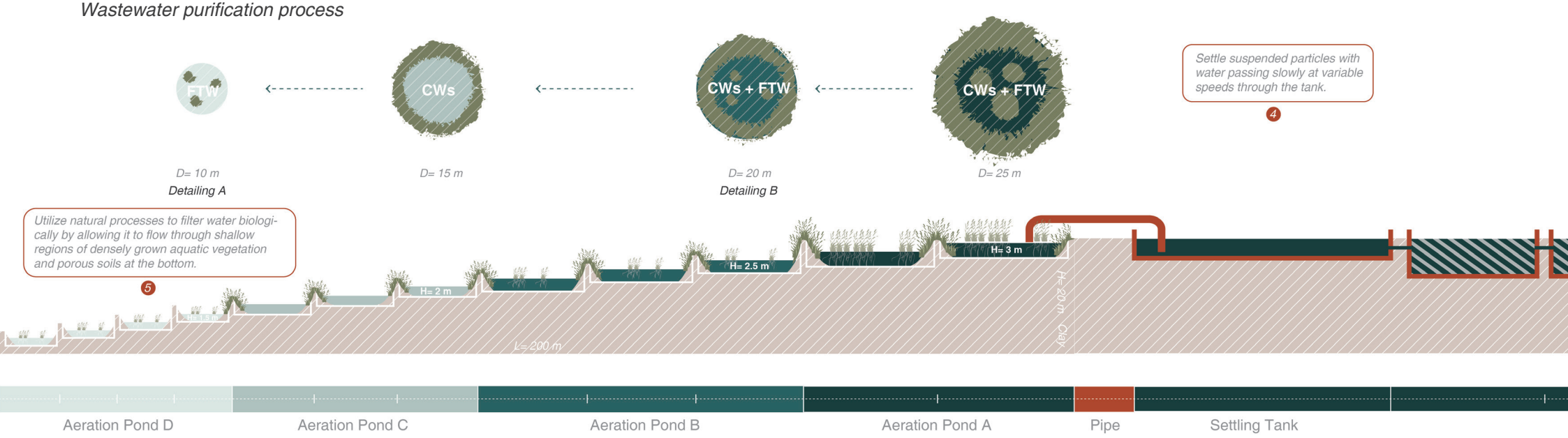
Wastewater Pipe

While creating new circulations for wastewater, the design also visualizes the usually hidden sewage treatment process into various landscapes that can be experienced and participated in, serving local residents and tourists together. According to the treatment process and landscape type, it can be roughly divided into four different experiences. The first three types (wastewater purification, agricultural reclamation, and landscape reclamation) will be introduced in the detailed design, and the last step, natural restoration, will be omitted (as it is only an extension of existing wetlands).

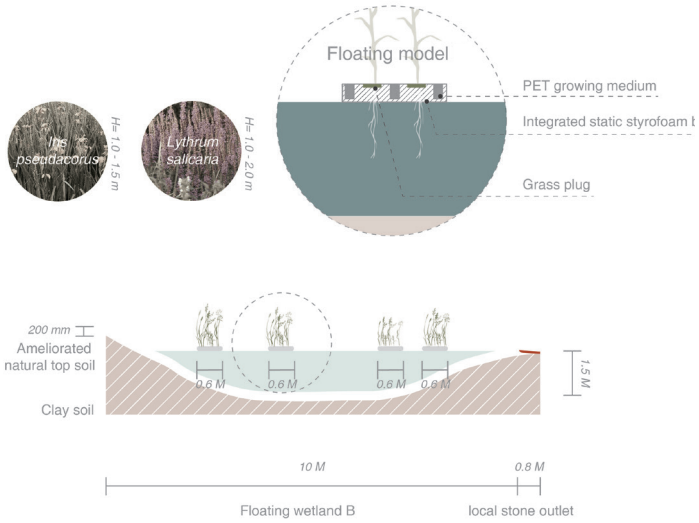
The first one is the wastewater park transformed from WWTP Sarra with a capacity of 26,000 p.e. (population equivalent), dealing with 6.24 million liters wastewater per day. The design aims to show the usually hidden process of wastewater purification. The design refers to the circular shape of the typical clarifier in WWTP, as well as the linear form of artificial pipelines and natural streams, giving the new representations of water. On the basis of unified forms, different materials (including steel and aquatic plants) and colors (referring to Matera's landscape color analysis) are chosen to distinguish artificial process from natural process. Consideration is given to the transition from motor transportation to cycling or hiking during visiting to the sustainable olive groves.


Bio solid shop
Parking lot & Bike rental
Digestate storage
Anaerobic tank
Pretreatment tank
Clarifier
Sludge removal
Bar screen
Settling tank
Terraced aeration ponds
Wastewater tank
Wastewater pipe
Viewing platform
Rainwater tank
Cycling route
Drip irrigation line
Irrigation pond
Irrigation channel
Hidden wastewater pipe
1
2
3
4
5
10 m
5 m
0 m
40 m
35 m
30 m
25 m
20 m
15 m
N
0
50
100
150 m

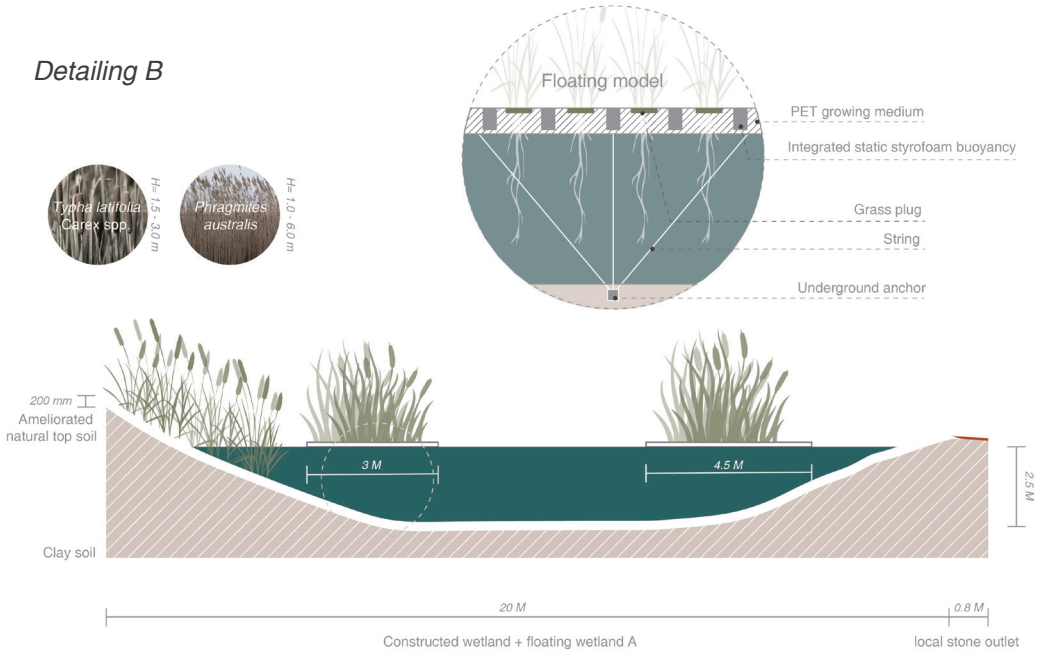
Wastewater purification process

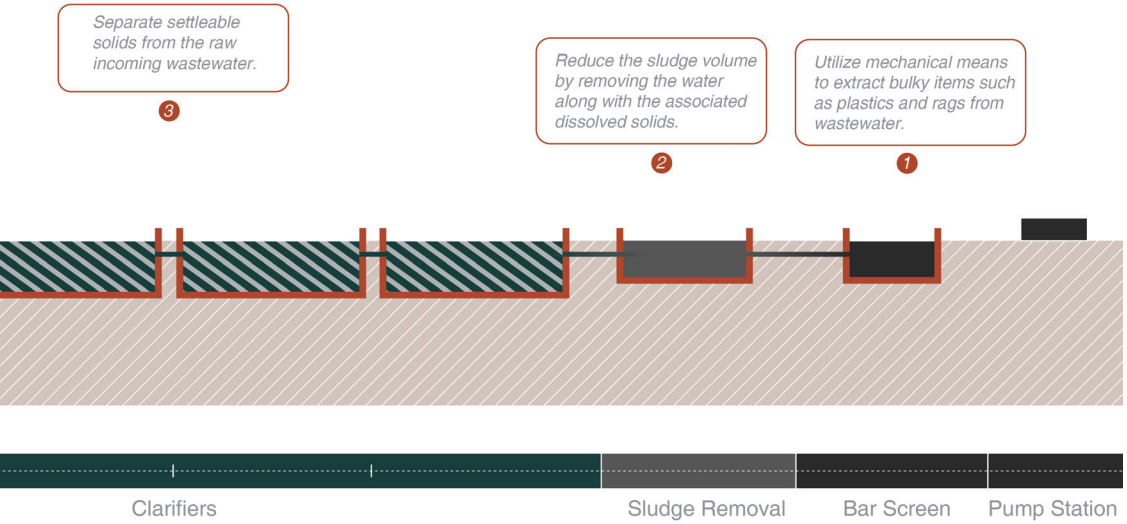


Detailing A



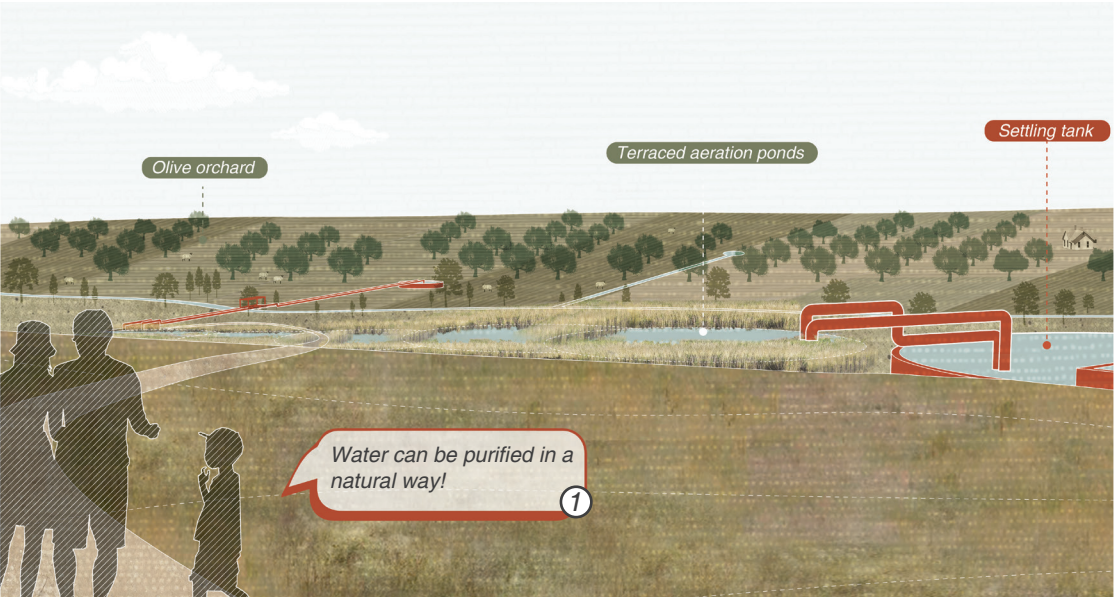
Detailing B

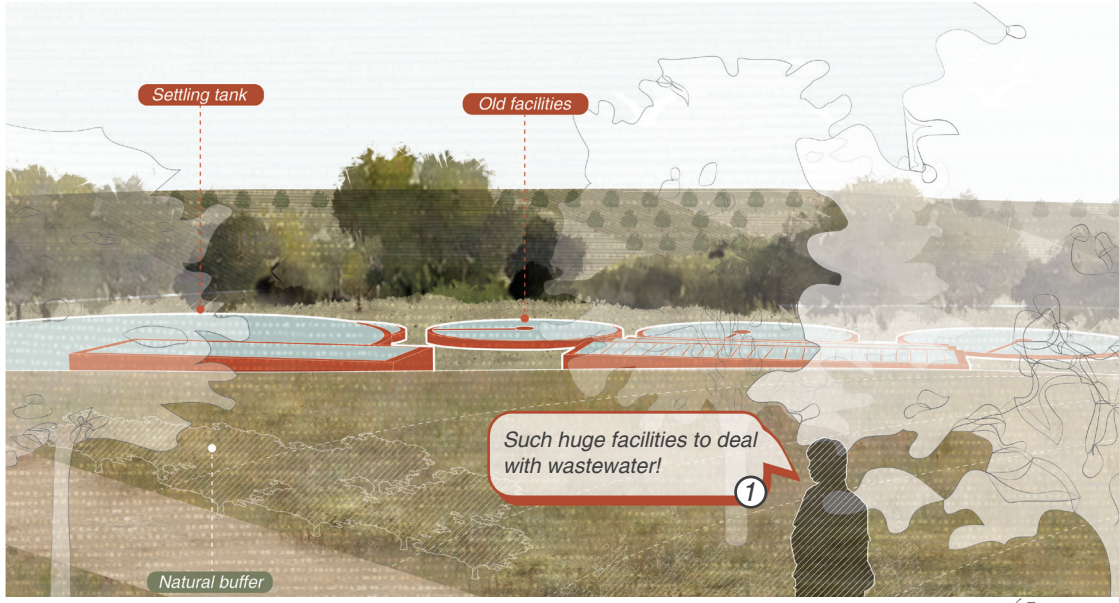




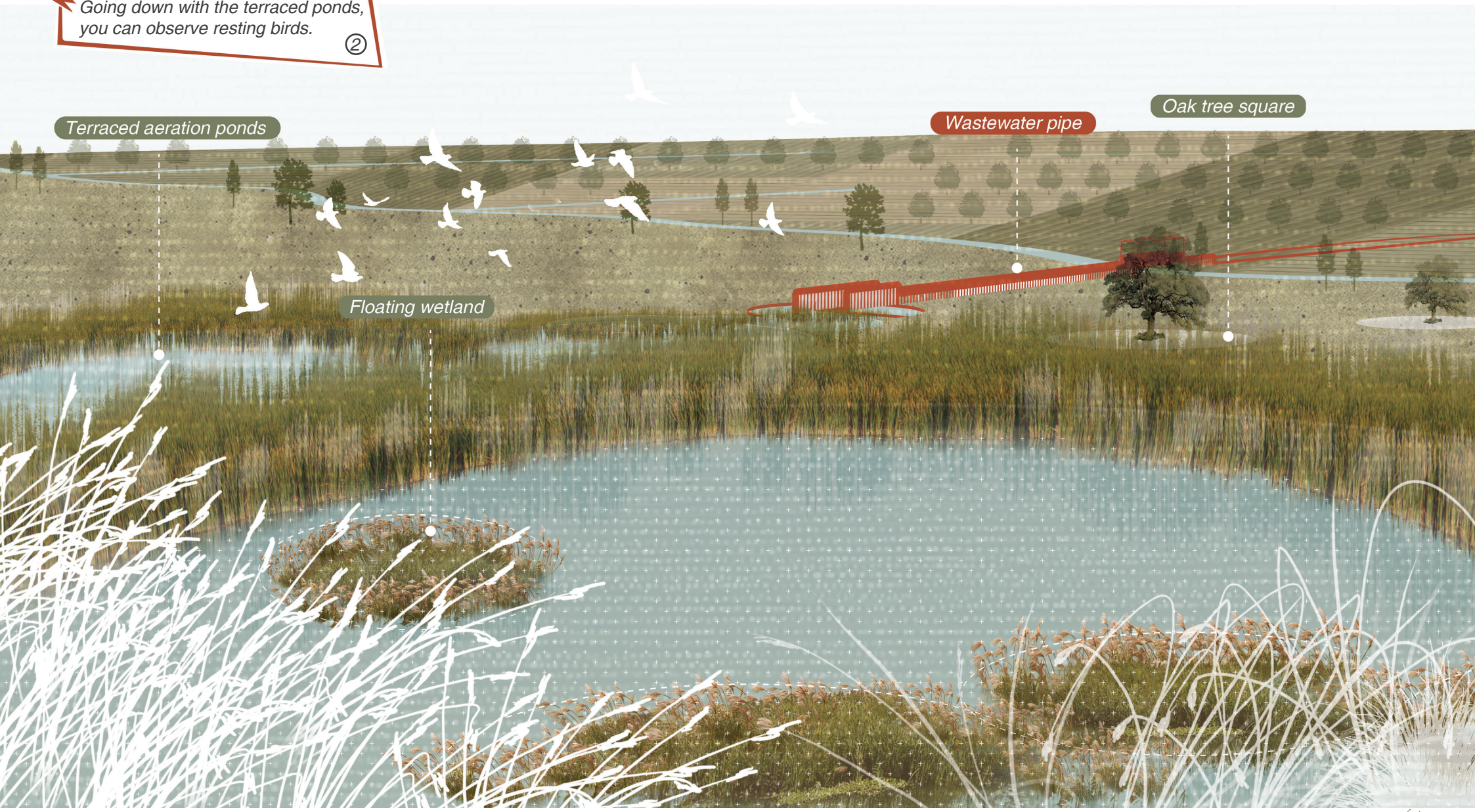
The left drawing shows the main workflow of an ecological wastewater treatment plant and the landscape experience at different steps.

The existing reserved sewage facilities are painted with dark orange on the exterior, and the terrain and vegetation allow tourists to view the installation from a high point with a safe distance. Circular aeration ponds of different scale are selected to form a terraced ecological water purification area. Constructed wetlands (CWs) with aquatic plants as surrounding and floating wetlands (FTW) in the center were combined for different landscape effects and higher purification efficiency. Local wetland plants of low cost are chosen to match with purification ponds of different sizes to achieve various landscape effects.

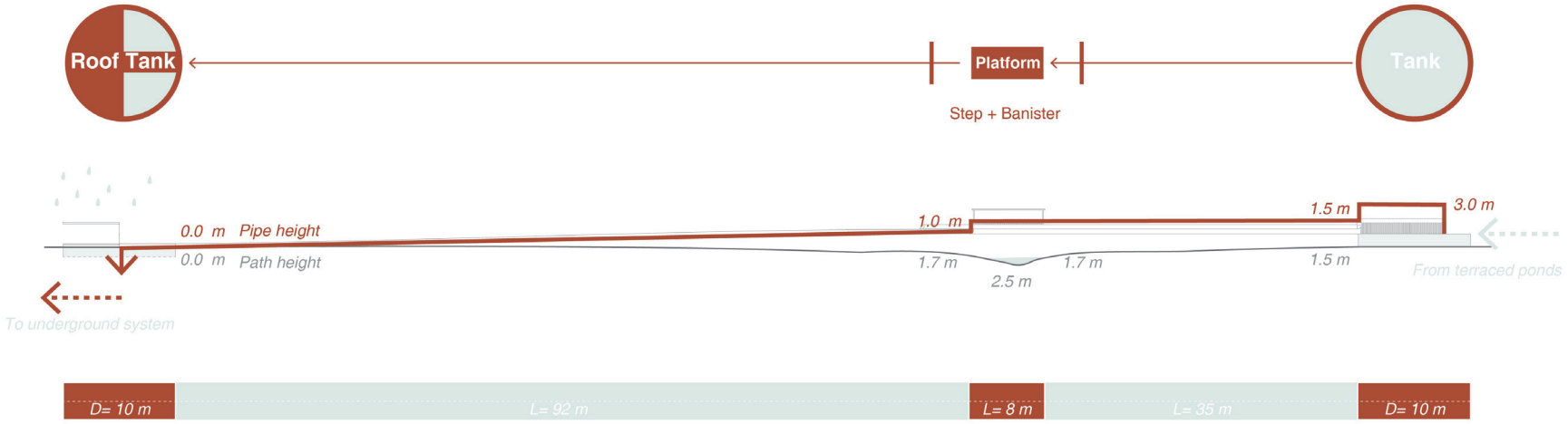


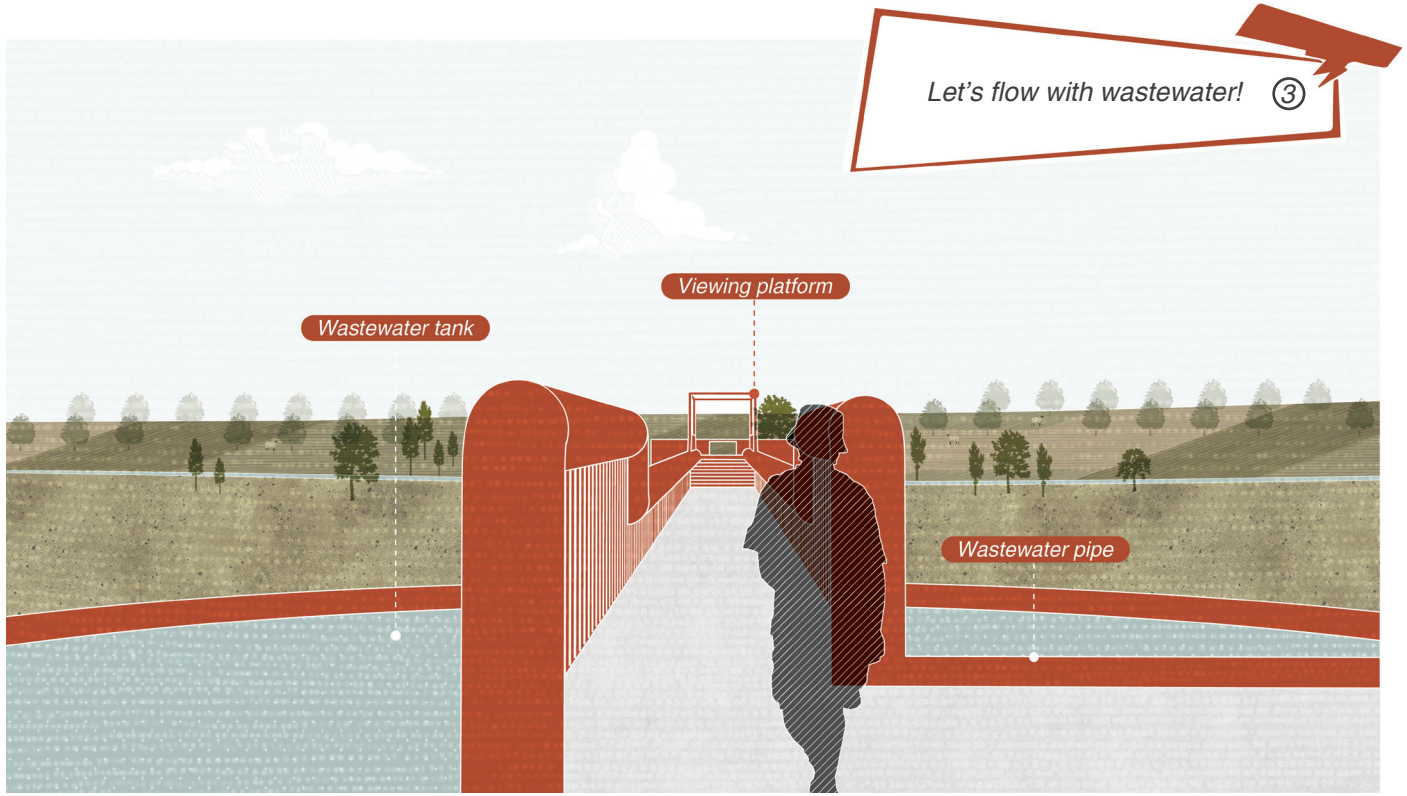


Going down with the terraced ponds, you can observe resting birds. ②



Wastewater collecting process

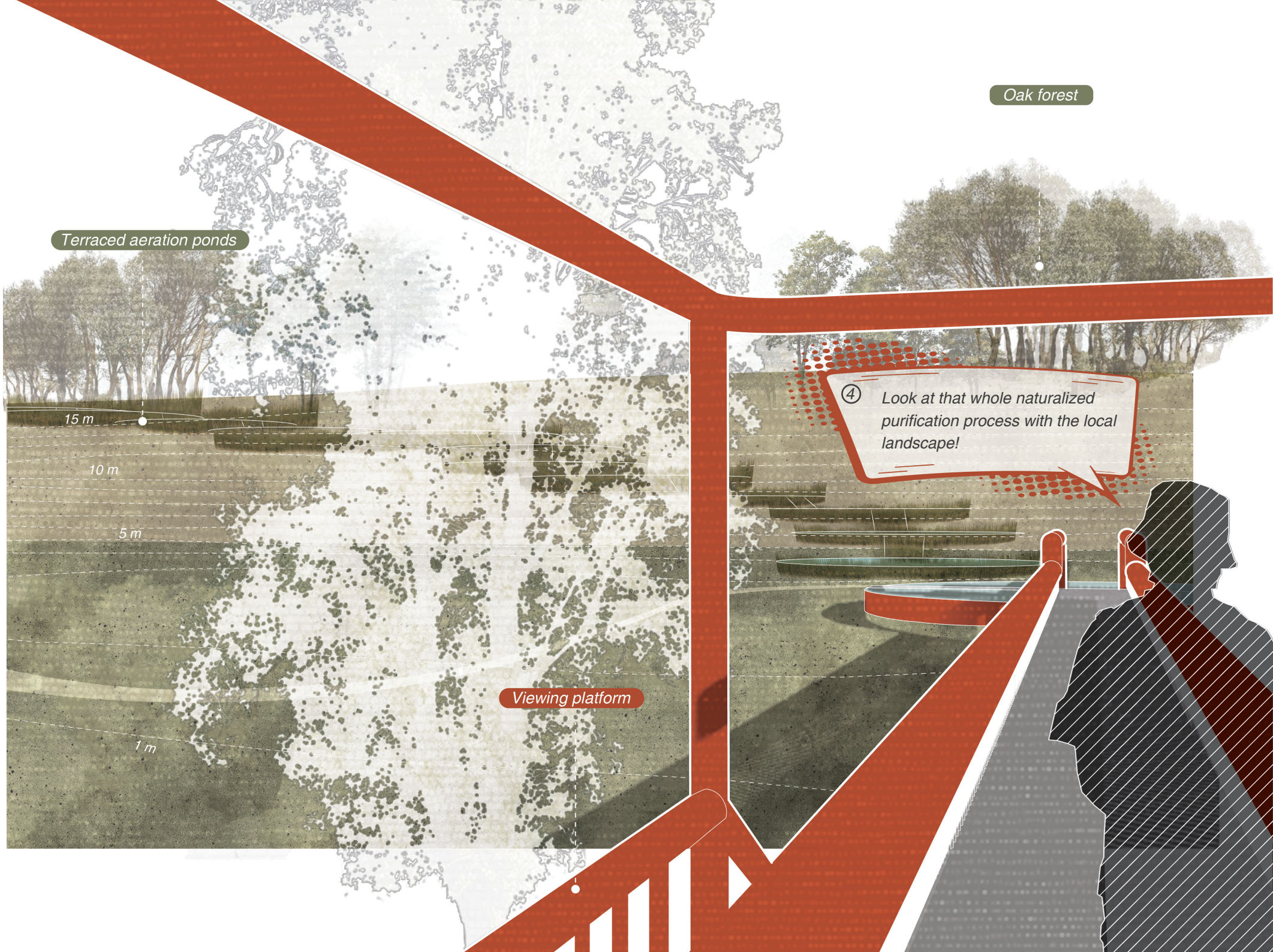




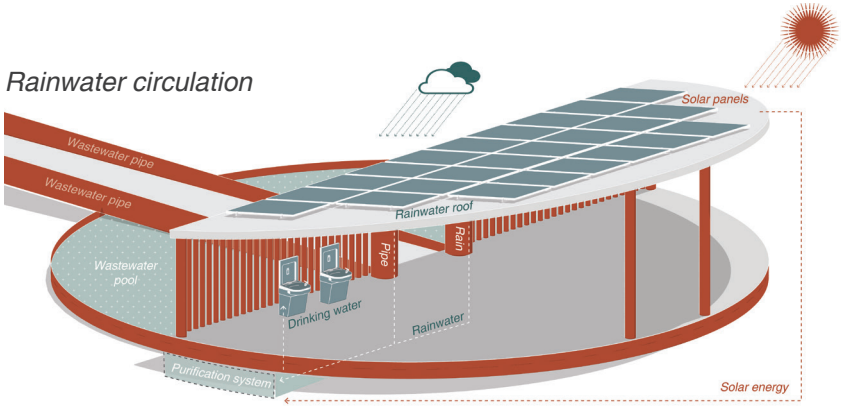
After the initial purification is completed, the water will be transported through aboveground pipelines to the olive orchard on the other side of the stream for irrigation. During the 155-meter distance, visitor will also flow with the water to the other side, and have the opportunity to participate in the sustainable water cycle.

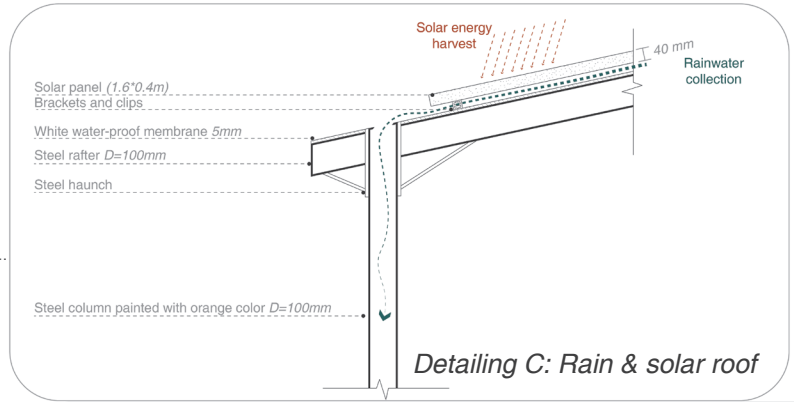
At the rainwater tank, solar and rainwater harvesting roofs are used to purify rainwater, where people can obtain fresh drinking water. In addition to being used as the main tool and symbol for transporting water, pipelines are also used as banisters, columns, platform frames, and pavings.


④
We're pumped up with wastewater in the middle of the wetland.
Ash-elm forest
Wastewater pipe
Viewing platform


Oak forest
Terraced aeration ponds
15 m
10 m
5 m
1 m
Viewing platform
④ Look at that whole naturalized purification process with the local landscape!

Rainwater circulation



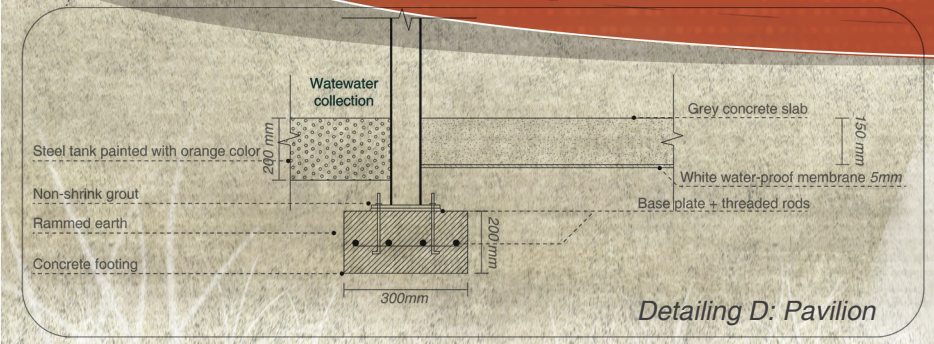


Detailing C: Rain & solar roof

Drinking water

Wastewater pool

Shady pavillion



Detailing D: Pavilion

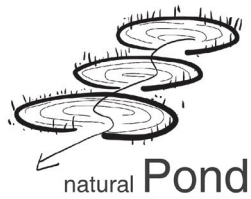
To olive orchards

Let's get some drinking water here before going to the olive groves. ⑤

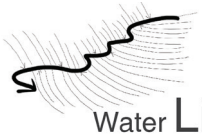


5.4 Reclamation:
from traditional to sustainable olive orchard

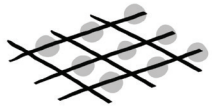
Landscape Representation



natural Pond



Water Line

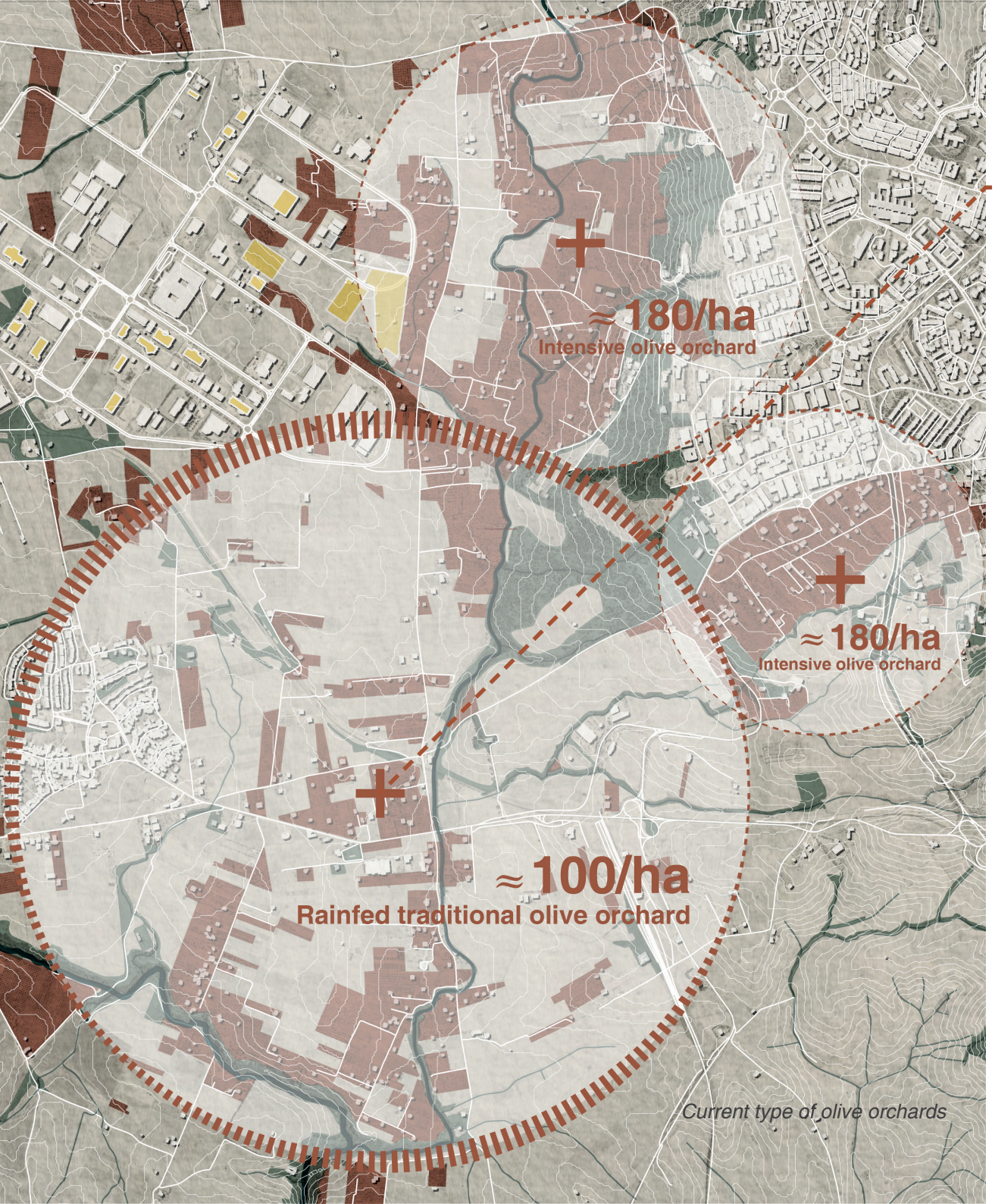


Green Interval

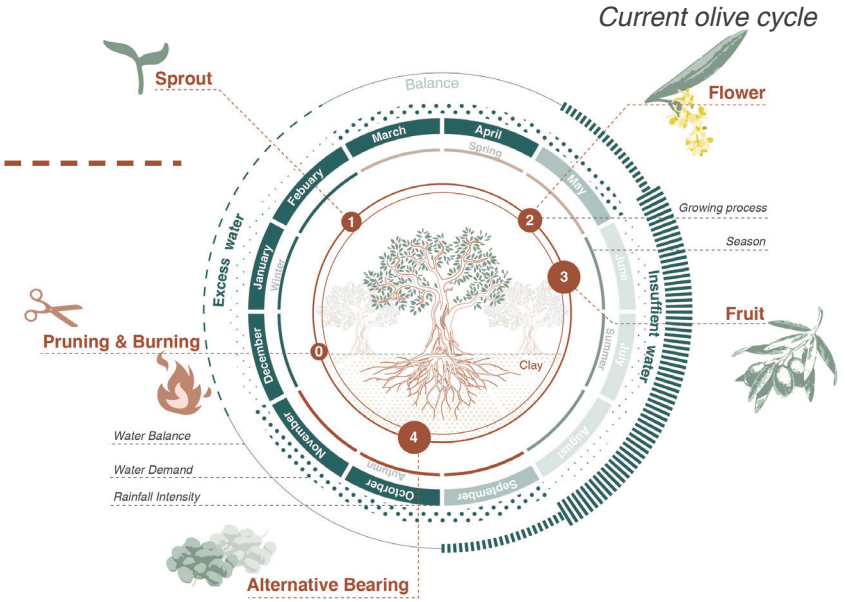
The treated sewage is still rich in certain nutrients such as N and P, and can be well reused for agriculture. A more ecological and sustainable olive orchard with the reclaimed wastewater is proposed to replace the traditional olive management here, dealing with the wastewater pollution, improving the profits of the orchard, as well as enhancing the landscape and ecological values.

The relationship between water and olive tree is the first step to drawing time for an olive orchard. The traditional olive orchard has about 80-100 olives per hectare, and it's often rainfed without irrigation equipment. A year can be divided into three periods, balanced, dry, wet periods for a more suitable result, based on the rain fall intensity and water demand of the olive tree. In addition, most traditional olive orchards here are privately owned small olive orchards, and landowners do not rely on olive cultivation as their main source of income. Considering the characteristics of small scale, numerous and dispersed growers, the design focuses on providing farmers with different choices, analyzing and evaluating the production profit, ecological impacts, and landscape effects of different olive orchard renovation options.

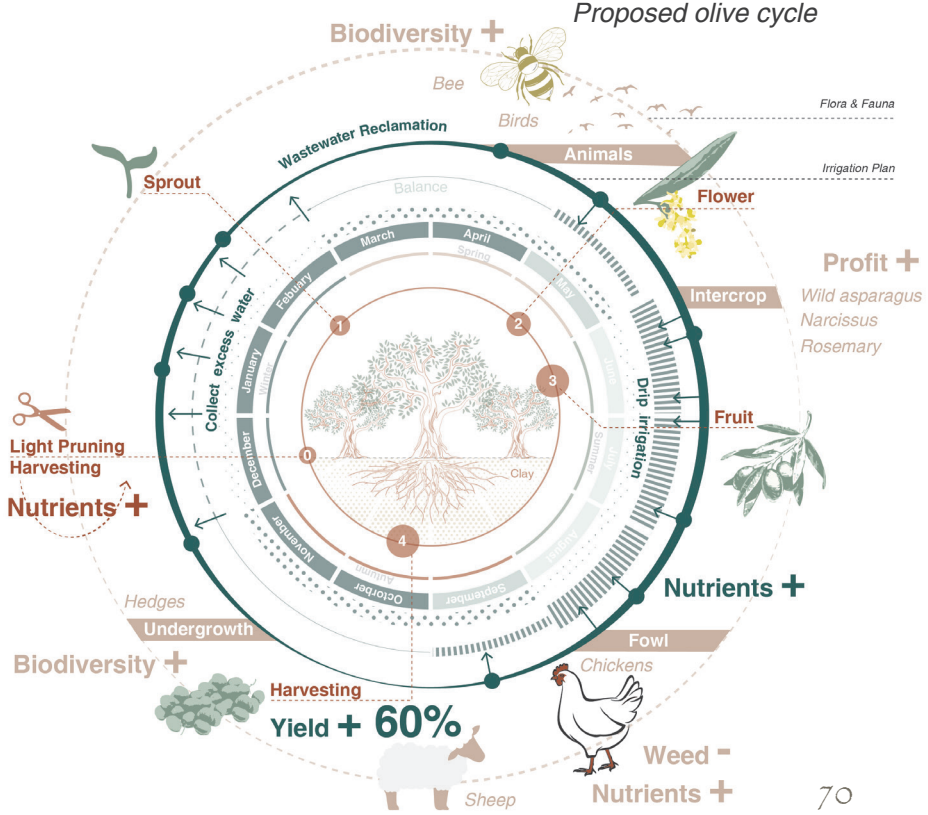
In the design of sewage irrigation systems for olive orchards, relevant design forms have also been applied to the site, giving the new representation of water in the rural area. Based on the grid form of olive orchards and the linear shape of natural waterways, the releasing pond is designed as a regular circular shape, and the irrigation canal is designed parallel to the olive planting line. At the same time, the repetition of ponds and channels in the landscape can also serve as a guiding system for visiting olive groves.

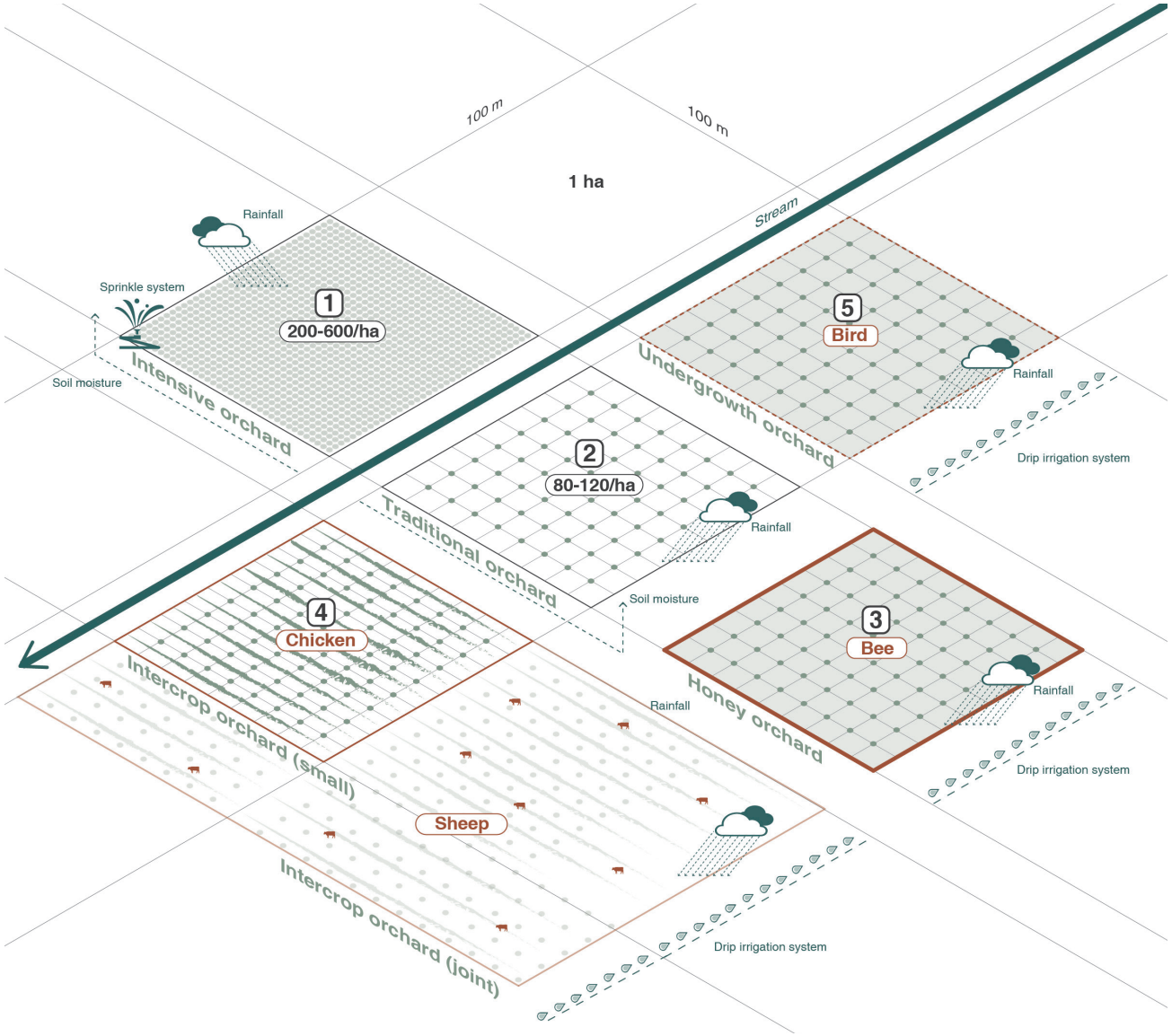


Current olive cycle

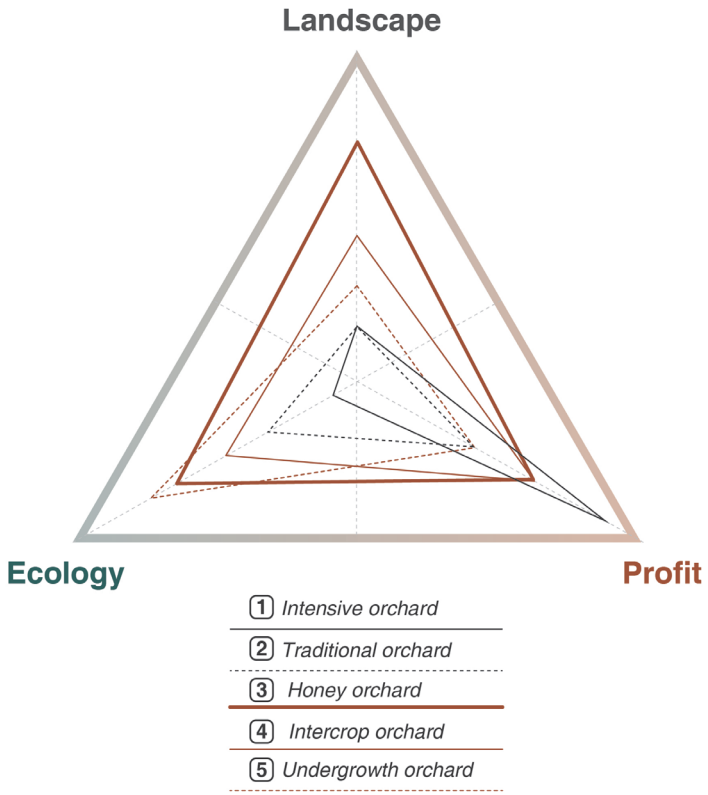


Proposed olive cycle



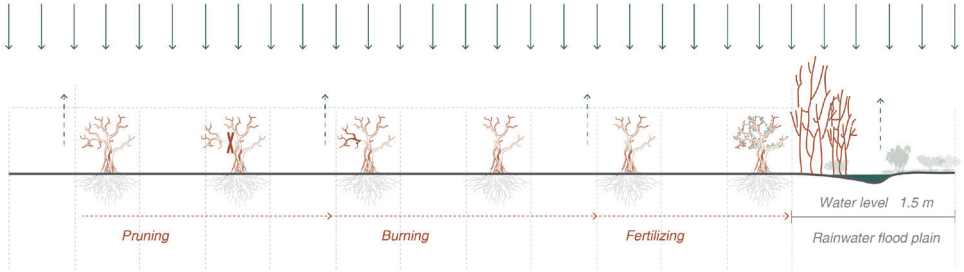


Olive orchard typology

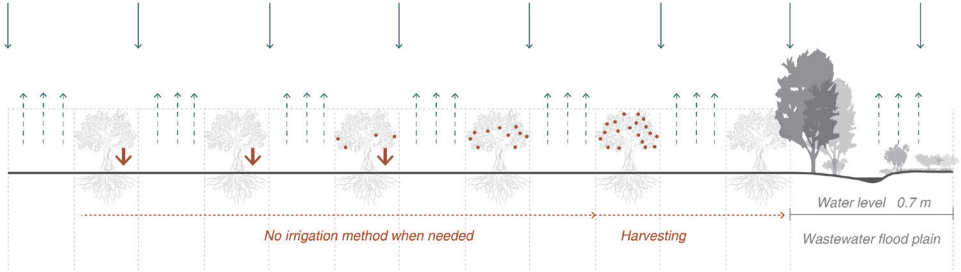


Olive orchard comparison

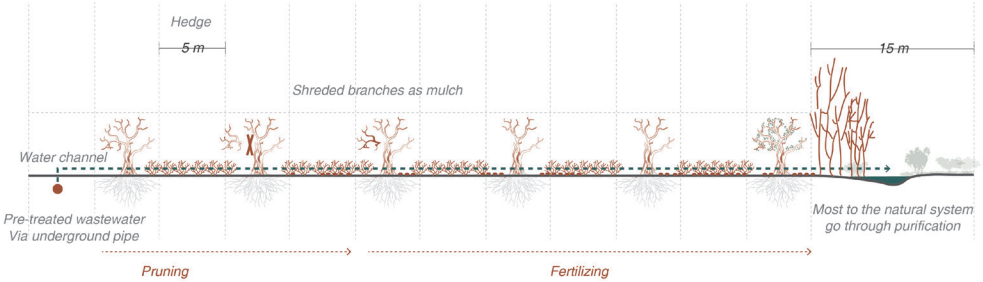
Wet season: December-February



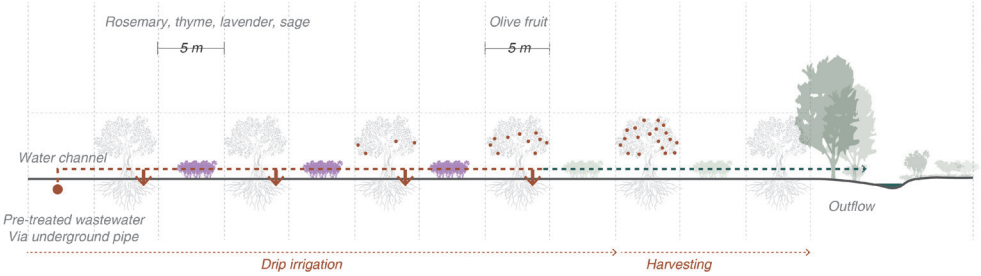
Dry season: May-September



Proposed undergrowth orchard



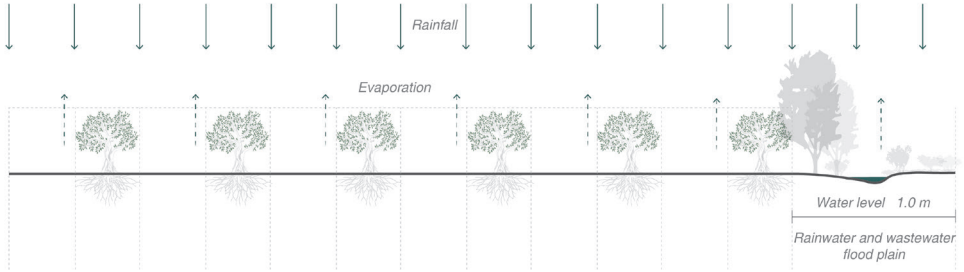
Proposed honey orchard



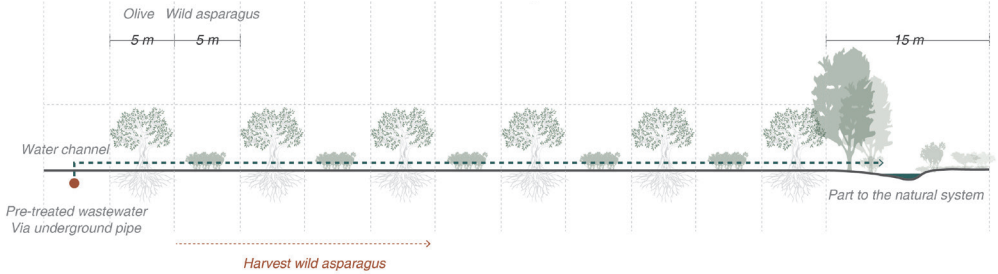




Balanced season: March-April, October-November



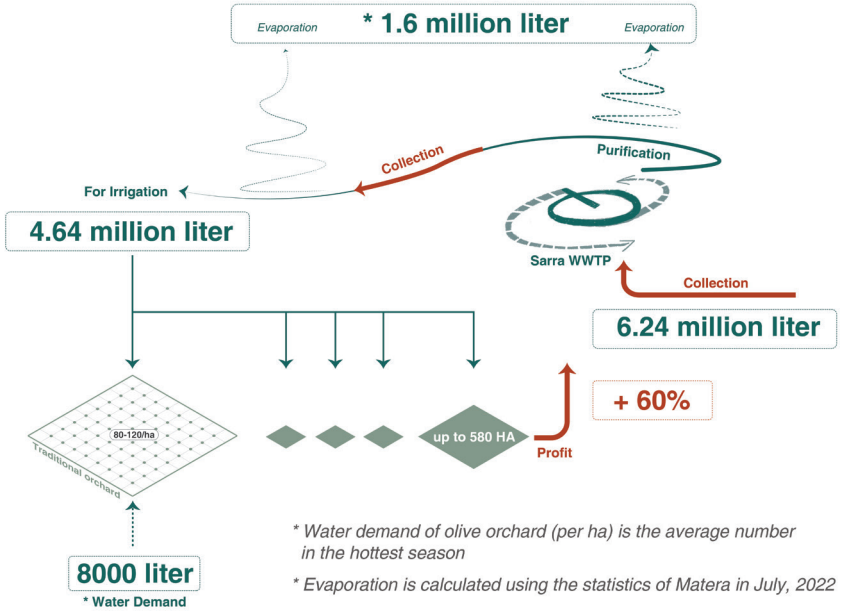
Proposed intercrop orchard





Four types of transformation of olive orchard are proposed, and I choose one period respectively to the show most striking landscape and influence. The sustainable orchard with chickens to weed and fertilize the plants, and wild asparagus as intercrop to make extra profit. And if landowners want to manage their olive groves together, they can also replace chicken with sheep for a larger area.

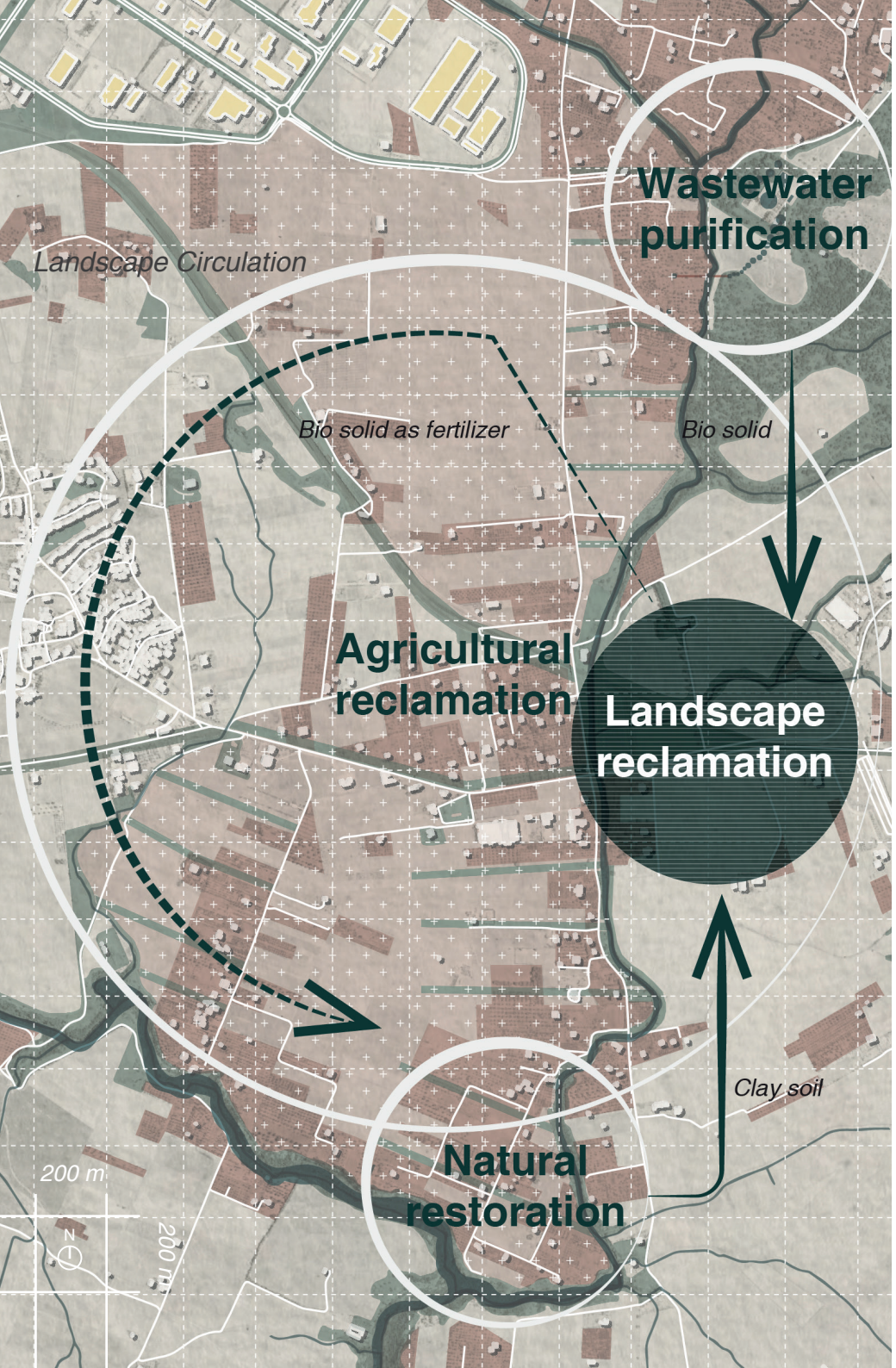
In the wet season, the brownish landscape with twigs and branches for migrant birds to rest and forage. At this stage, as olive trees do not require irrigation, the water in the system will be abundant, and the ecological attraction around the irrigation channel will greatly increase. In dry season, the honey orchard can make the most attracting landscape for visitors dropping by the rural area. The water in the system is relatively less retained, but the biodiversity in the olive orchard is enhanced due to the presence of bees and the greener ground cover.



** Water demand of olive orchard (per ha) is the average number in the hottest season*

** Evaporation is calculated using the statistics of Matera in July, 2022*

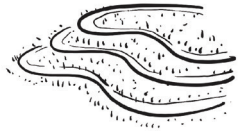
5.5 Reclamation: bio solids park



Landscape Representation



Bio solid Mound



Flower Meadow

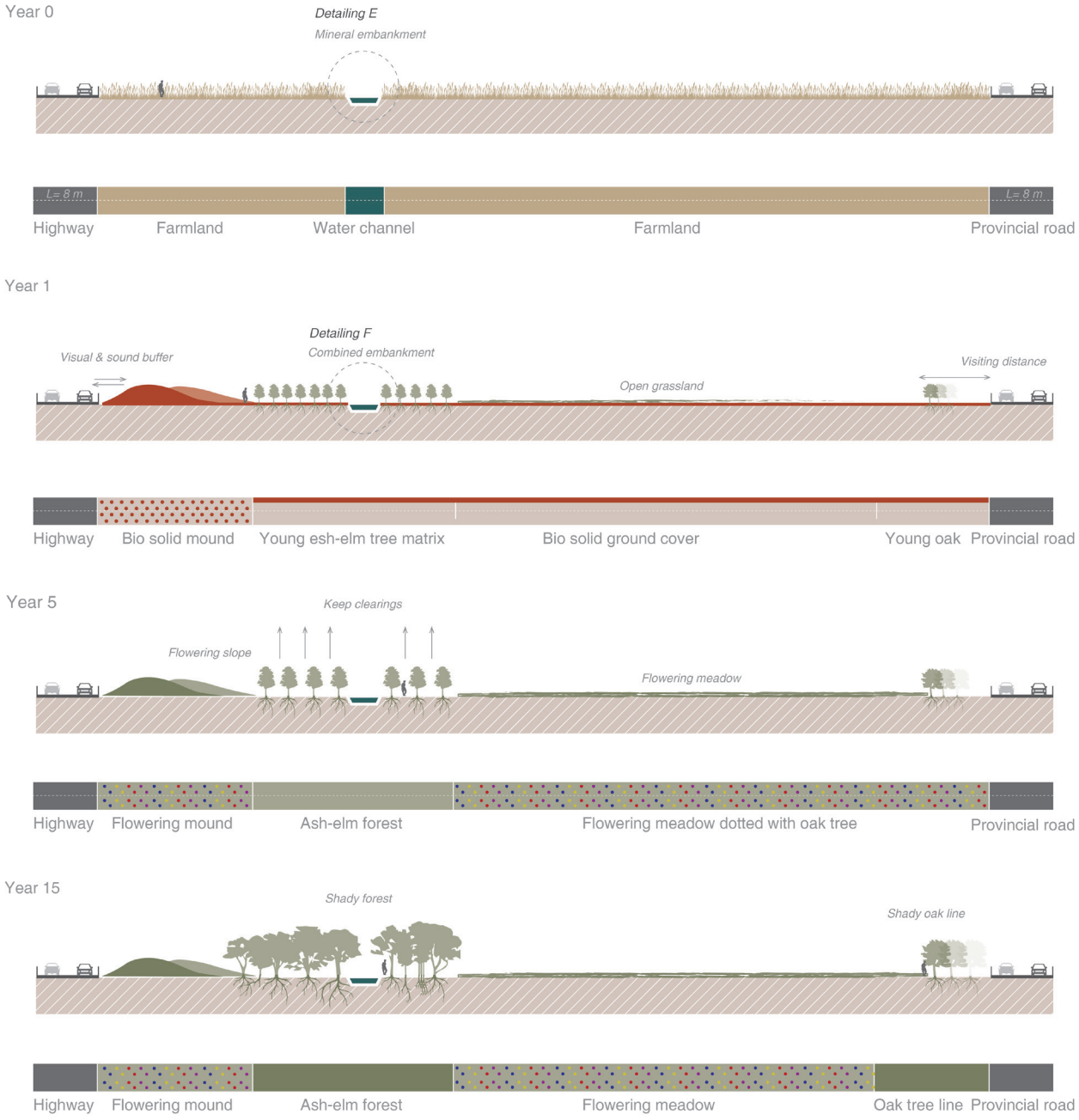
Another by-product from wastewater purification is bio solid, an organic matter. The sludge will be separated from water and dried with rapid high temperature at the wastewater park, and the produced bio solid with abundant nutrients will be transported to this bio solids park for soil improvement, landscaping, as well as potential fertilisers for local farmers. And the park also reuses the clay soil from the expansion of the wetland for landscaping.

The utilization of recycled materials provides the possibility for the transformation of sites from degraded agricultural land to sustainable public green space. On the one hand, the site provides a green space with high reachability for the surrounding residents; on the other hand, the recycling of sewage materials on the site also brings benefits to farmers.

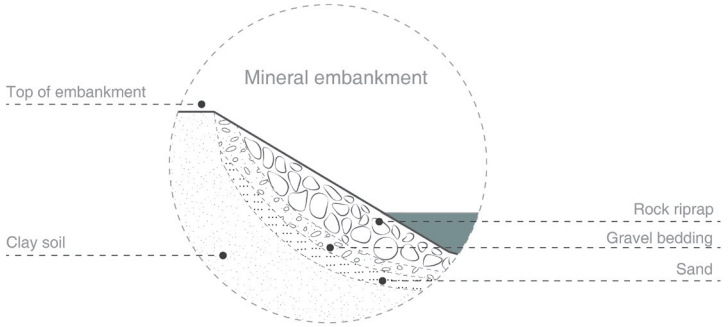
In the process of landscape renovation, the role of time on landscape restoration and development is taken into account. In the first year, the main focus will be preliminary soil restoration and landscape intervention, creating a relatively open tree plaza and grassland. In the fifth year, necessary maintenance work will be carried out as the trees grow, and at the same time, a planned maintenance will be carried out for the arid flower meadow to ensure the diversity of the landscape. In the fifteenth year, the elm-ash forest will be almost fully developed, forming a relatively shaded space within the park. The representation of farmland has also been identified and applied to the park, including the bio solid mound transformed from wheat mound as the sound and visual buffer, and the path referenced to the harvesting line in the wheat field has also been constructed in the flower meadow.


Olive orchard
Bio soild mound
Elm-ash forest
Solitary oak tree
Parking lot & Bike rental
Recovered meadows
Bio solid shop
Motor traffic entrance
Pedestrian entrance
Highway_SS655 (Speed 60km/h)
Motor traffic entrance
Provincial Road SP8 (Speed 30km/h)
6
N
0
50
100
150 m

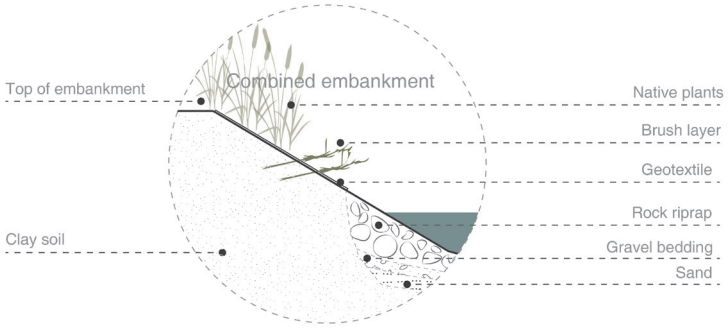
Landscape development through time



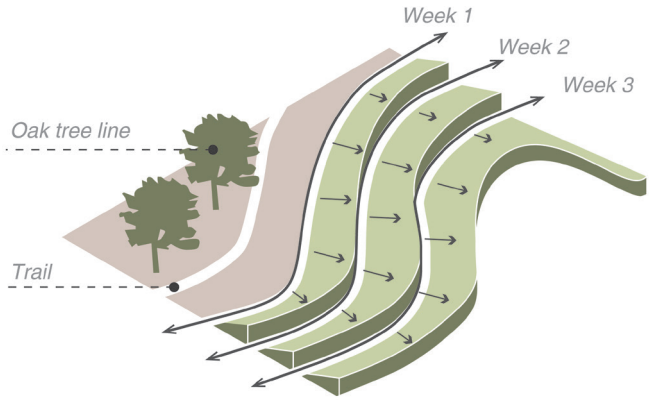
Detailing E



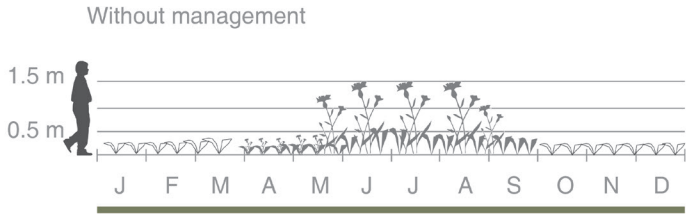
Detailing F

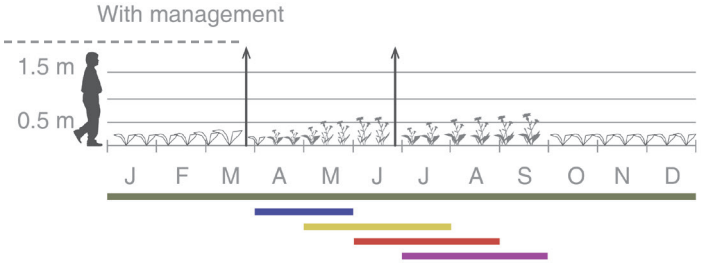


Management of flower meadow









06 CONCLUSION & REFLECTION



Cirluar system



Social network



Green space



Fountain



Grabiglioni



WWTP

Conclusion

This thesis explores the traditional water system of Sassi di Matera and finds out that water plays an important role as a sustainable resource, the social center, and the chance for green space. In addition, by exploring the overall history and culture of Matera, different symbolic elements of water (public fountains, grabiglioni, WWTP) are chosen as the representations of water in different landscapes.

The water wisdom and representation become the design strategies to optimize Matera's water circulation, improve the network of public space, and enhance the blue-green network. Ultimately, the sustainable development goals of the region can be achieved by using a landscape approach as the start.

As a resource, the sustainable use of water can have a positive impact on agricultural activities, public life, and the natural environment. At the same time, the sustainable use of water has become the cornerstone of regional sustainable development in terms of landscape changes. The protection and inheritance of physical cultural heritage can be not only done on-site, but also across regions. Sassi di Matera's water wisdoms can not only be applied to Matera, but can also be used as a reference for other arid regions, especially southern Italy, which faces similar climates and relies on agriculture as its pillar industry. In addition, we should encourage cities like Matera that have Sassi di Matera as the only cultural tourism center to consider landscape planning and sustainable development in a larger scale.

Reflection

This part is organized by academic revelance, design focus, social and moral aspects of this project.

Academic relevance

1. Research for design
The project starts with careful investigations about the traditional water system in Sassi di Matera, and end with a project with different water element designs across the region. The close relationship between research and design is important for understanding the project. One the one hand, the research and design focus on different ways of water recycling at different places and scales; on the other hand, they also show a continuity of the hidden water circularity relevant to people living in the area from past to the present. The research part discusses about the current lost cultural heritage (water harvesting system) in Sassi as a living system in the past, revealing its circular system, social network and green space. While, the design part aims to offer new landscape solutions to today's problems, guided by old wisdoms from Sassi.

2. Specificity and universality
The water circulation, green space and social life in the traditional water system of Sassi are not only applicable to Matera, but can also be used as a good example in the design of more arid and water-scarce areas. This thesis shows the possibility of design practice in Matera. Through a series of problem analysis, selection of water elements and research of water cycles, and representation of local landscape, the theory is embodied in a specific space with new scenarios.

3. Flowscapes studio
The Flowscapes studio, the MSc Landscape Architecture graduation program, offers a diverse range of approaches to landscape design and aims to create flows to influence our society in different ways. This thesis is done in the Circular Water Stories (CWS) lab, where water is seen as an important flow in landscape design. As a result, the hidden flows and circularity of water help to build a sustainable living system for people.

4. Practice of Landscape Architecture
This project explores the identity of landscape designers as coordinators between land and stakeholders, achieving a future vision that benefits both parties. For the agricultural industry, farmers may only consider the benefits and overlook the ecological and landscape value that their land can achieve. Design encourages providing more choices for land owners, rather than having a top to bottom method. Although a variety of renovation plans were provided for current small olive orchard, there is still a lot of room for improvement due to the lack of site research and interviews with land owners.

Design focus

1. Sustainability of water
Sustainability is the most important concept in this thesis, with it researched in Sassi and designed in Matera. The sustainable use of wastewater solves the water crisis of local agriculture, the dismissed drinking water from public fountains revitalizes the community life, and the rainwater controlled along the grabiglioni in Sassi di Matera reminds people of the hidden water city.

2. Different design scales
Designs proposed for the three water elements focus on different scales because they vary in size and water capacity. The drinking water fountain, as the most basic water unit scattered in city, has the potential of working locally as a neighborhood unit. The grabiglioni, now a hidden memory in old Sassi, has the perfect linear form to bring everything together for showing a bigger circularity in Sassi scale. The wastewater treatment plant, with the biggest water capacity, is the most promising supply for new green spaces in this dry region, so it can contribute to the big changes in the regional scale. The three elements come together to provide a future vision of the hidden water region by new zoning and routing system.

Social and moral aspects

1. Cultural heritage under tourism
Through the design processes, the cultural heritage is seen as a significant topic. As a cultural heritage, Sassi di Matera, on the one hand, has made big contribution to the local economy due to the booming tourism, and on the other hand, it has also brought an impact on the lives of the local people living with the tangible cultural heritage. Under the influence of the tourism industry, the identity of Sassi di Matera as a stone city has been continuously promoted and rendered as the only cultural symbol in the eyes of tourists, while its internal mechanics ensuring the sustainability of living has been forgotten. Therefore, this thesis proposes a cultural heritage design that does not directly design the cultural heritage, but focus on the new design for local people and their needs. In addition, the naïve image of Sassi can be replaced by a panorama of Matera. The local rural land-

scape, stunning natural landscape, as well as the rural and urban life will be introduced to all.

2. Sustainability of development

The international fame of Sassi di Matera also made the rest of the city an invisible part. The life of local out of Sassi seems to be separated from that booming cultural icon. This trend leads to the discussion of the sustainable development of the region. The concept of sustainable development acknowledges that issues related to our health, culture, finance, security, and environment are not isolated, in conflict with one another, but rather are interrelated and interdependent. According to the UN Sustainable Development Goals framework, this is explained simply as the 3 pillars or 'triple bottom line' of economy, society and environment. This project tries to use a landscape approach as the start to unite different entities across Matera, inf luencing the local economy and society. The underdevelopment of southern Italy in general also makes this project bring new insights to the southern territory. The low-investment approach to dealing with wastewater, and flexible options for olive farmers to have an ecological friendly orchard with promising economical results would be good examples for the sustainable development of the south.

3. Southern question

Southern Question (ie. the coexistence of an industrialized North side by side with an underdeveloped South.) is the main social problem confronting Italian society from the days of national unification in the latter part of the nineteenth century to the present (Piccone, 1974). Following the war, the agricultural industry witnessed a notable shift in its practices influenced by the implementation of the announced land reform, which was meant to address the unevenness in economic development between southern Italy–mainly rural and lacking infrastructures and job opportunities. Apart from the prevalent cereal monoculture (wheat and olive), which was typical for the sector, a significant change occurred with the transfer of land ownership from large-scale owners to smaller and medium-sized proprietors.

Facing the future sustainable development of southern Italy, it is meaningful to seek solutions at a larger landscape level to achieve a balance between economic development and environmental protection. In addition, the value of agricultural landscapes in ecology and tourism can also help economic development. Smaller design interventions and more choices for farmers which do not need big capitals but with promising economic results, and investment from municipality for public entities would be meaningful.

References

Austin, G. (2013). Multifunctional Wastewater Treatment Landscapes. Landscape Journal, 32(2), 199–214. http://www.jstor.org/stable/43323939

Bernardo, M., & Pascale, F. D. (2016). Matera (Basilicata, Southern Italy): A European Model of Reuse, Sustainability and Resilience. Advances in Economics and Business, 4(1), 26–36. https://doi.org/10.13189/AEB.2016.040104

Bresson, H. C. (1951). Retrieved from https://www.magnumphotos.com/arts-culture/travel/henri-cartier-bresson-in-matera/

CAMARDELLI, M. A. R. I. A. L. U. C. I. A. (2017). Practices and forms of open space at territorial scale: A comparison between two cities crossed by minerals rivers. Proceedings 24th ISUF 2017 - City and Territory in the Globalization Age.

Canora, Filomena & D'Angella, Annachiara & Aiello, Antonello. (2014). Quantitative assessment of the sensitivity to desertification in the Bradano River basin (Basilicata, southern Italy). Journal of Maps. 11. 1-15. 10.1080/17445647.2014.980857.

Chiarella, Domenico & Festa, Vincenzo & Sabato, Luisa & Tropeano, Marcello. (2019). The city of Matera and its 'Sassi' (Italy): an opportunity to broadcast geology in the European Capital of Culture 2019. Geology Today. 35. 174-178. 10.1111/gto.12283.

Croce A (2015) Vascular flora of eight water reservoir areas in southern Italy. Check List 11(2): 1593. https://doi.org/10.15560/11.2.1593
Fiorenza, R. (n.d.). Retrieved from https://www.rodolfofiorenza.com/reportage/matera-1976/

Foschino, F., & Centonze, S. (2019). Le Neviere di Matera - Speciale. Rivista Mathera.

Fontanelle.org. (2021). Retrieved from https://www.fontanelle.org/Fontanella-Via-Castello-75100-Matera-MT-Italia-SagDjp8VoccxYz.aspx

Frediani, Gianluca. (2012). Earth-City: The "Sassi" settlement in Matera. Space and identity between utopia and rehabilitation.. Journal of Comparative Studies in Architecture. 4-15.

Gianpiero, P. (2020). Retrieved from http://www.materacittanarrata.it/mSite/pp.asp?lang=2&pan=2&ep=3

Global Design News. (2022). Retrieved from https://globaldesignnews.com/turenscape-transforms-a-waste-dump-into-a-striking-nature-based-wastewater-remediation-system-helping-to-restore-the-degraded-wetland-ecosystem-in-handan/

Grano, Maria. (2020). Palombari, cisterne e pozzi per l'approvigionamento idrico nei Sassi di Matera (Basilicata). Il Capitale Culturale Studies on the Value of Cultural Heritage. 21. 377-389. 10.131382039-23622076.

Laureano P., Cirella A. Water and life: the women ' s traditional knowledge in the ' Sassi ' of Matera, Italy. In: Hamdy A. (ed.), Sagardoy J.A. (ed.), Quagliariello R. (ed.), Trisorio-Liuzzi G. (ed.). Integration of Gender Dimension in water management in the Mediterranean region: INGEDI Project. Bari: CIHEAM, 2 004. p. 9 3-9 6 (Option s Méditerranéennes: Série A. Séminaires Méditerranéens; n .62)

Manfreda, S., Mita, L., Dal Sasso, S. F., Dibernardi, F. R., Ermini, R., Mininni, M. V., ... & Fiorentino, M. LA GESTIONE DELLE RISORSE IDRICHE NELLA CITTÀ DEI SASSI (MATERA) WATER RESOURCES MANAGEMENT IN THE CITY OF SASSI (MATERA).

Masi, Salvatore & Palese, Assunta & Celano, Giuseppe & Xiloyannis, Cristos. (2013). Treated municipal wastewater for irrigation of olive trees.

Michele Tenzon (2018) Rural modernity in post-war Southern Italy: the La Martella village in Matera, The Journal of Architecture, 23:3, 498-522, DOI:10.1080/13602365.2018.1460731

Morphocode Academy. (2019). Retrieved from https://morphocode.com/the-5-minute-walk/

Monica, Luca & Bergamaschi, Luca. (2019). From the Thirties to post-war reconstruction. The Land Reclamation Consortia and rural architecture in Italy.. SHS Web of Conferences. 63. 03001. 10.1051/shsconf/20196303001.

Municipality of Matera. (2021). Retrieved from https://www.wikimatera.it/cosa-vedere-a-matera/il-palombaro-lungo-ed-il-sistema-di-conservazione-delle-ac-

que/i-grabiglioni-nei-sassi/

Municipality of Matera. (2022). Retrieved from http://dati.comune.matera.it/

Municipality of Matera. (2022). Retrieved from https://www.materawelcome.it/en/perche-matera/matera-e-lacqua/

Oliver, S. (1994). The Political Ecology of Deforestation: The Case of the Basilicata Region of Italy. Environmental Conservation, 21(1), 72-75. doi:10.1017/S0376892900024139

OLIVER, S. (1999). The Causes of Erosive Land Degradation in the Basilicata Region of Italy. Geography, 84(4), 331–344. http://www.jstor.org/stable/40573338

Pangea Project Ancient Techniques Research Center. (1970). Retrieved from http://www.pangea-project.org/ambienti-sotterranei/

Parco Archeologico Storico Naturale delle Chiese Rupestri del Materano. (2021). Retrieved from http://www.parcomurgia.it/

Piccone, P. (1974). Introduction: The “Southern Question” in Italian Sociology. International Journal of Sociology, 4(2/3), 3–6. http://www.jstor.org/stable/20629677

Pontrandolfi, Raffaele. (2020). URBAN-RURAL: “TIBURTINO” DISTRICT IN ROME AND RURAL VILLAGE “LA MARTELLA” IN MATERA AS EMBLEMATIC CASES OF SETTLEMENTS DURING THE ITALIAN RECONSTRUCTION. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. XLIV-M-1-2020. 789-796. 10.5194/isprs-achives-XLIV-M-1-2020-789-2020.

P. Beneduce, V. Festa, R. Francioso, M. Schiattarella, M. Tropeano, Conf licting drainage patterns in the Matera Horst Area, southern Italy,Physics and Chemistry of the Earth, Parts A/B/C,Volume 29,Issue 10,2004,Pages 717-724,ISSN 1474-7065,https://doi.org/10.1016/j.pce.2004.03.009.

Ponte-e-Sousa, Clara. (2014). Wildflower Meadows Management In Mediterranean Climate.

Rafael Navarro Murcia. Nutrición y Sanidad del Olivar. (n.d.). What is the recommended frequency for olive trees irrigation? Retrieved from https://blog.esao.es/en/what-is-the-recommended-frequency-for-olive-trees-irrigation

Rotolo, marina. (2021). La production de la ville en contexte labellisé Matera, Capitale européenne de la culture en 2019.

Rose Etherington. (2022). Retrieved from https://www.dezeen.com/2010/05/27/between-the-waters-by-ooze-and-marjetica-potrc/

Savino, F. (2022). Retrieved from https://arkt.space/en/mater-era-the-origins-of-a-universal-garden/

Scrivano, P. (2005). Signs of Americanization in Italian Domestic Life: Italy’s Postwar Conversion to Consumerism. Journal of Contemporary History, 40(2), 317–340. http://www.jstor.org/stable/30036326

TOXEY, A. (2004). Reinventing the Cave: Competing Images, Interpretations, and Representations of Matera, Italy. Traditional Dwellings and Settlements Review, 15(2), 61–78. http://www.jstor.org/stable/41758044

Trulli, Ettore & Torretta, Vincenzo & Rada, Elena. (2016). Water Restoration of an Urbanized Karst Stream by Free-Water-Surface Constructed Wetlands as Municipal Wastewater Posttreatment. UPB Scientific Bulletin, Series D: Mechanical Engineering. 78. 163-174.

Trulli, Ettore & Torretta, Vincenzo & Rada, Elena & Istrate, Irina & Papa, Enrico. (2014). MODELING FOR USE OF WATER IN AGRICULTURE [MODELLAZIONE PER L’USO DELLE ACQUE IN AGRICOLTURA]. INMATEH-Agricultural Engineering. 44. 121-128.

Viti, E., & Lupo, T. (2020). Appunti di Matera sotterranea.