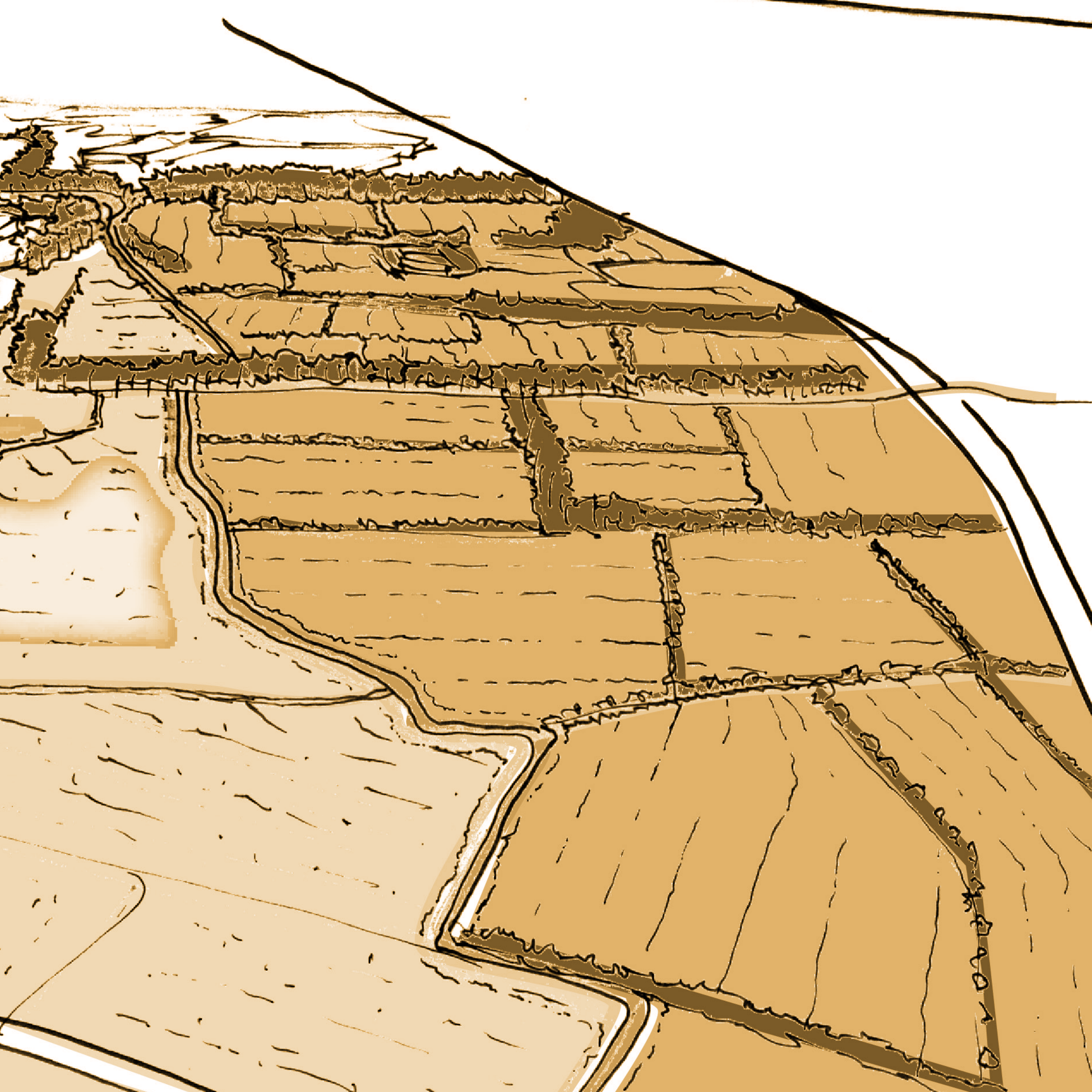
RICE

Reimagining the Integration of Cultivation and Ecosystems

Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

Boris L. Bakker



REIMAGINING THE INTEGRATION OF CULTIVATION AND ECOSYSTEMS

CLIMATE ADAPTATION STRATEGIES FOR THE RICE PRODUCTION LANDSCAPE OF NORTHERN ITALY: THE CONTEXT OF THE TICINO, SESIA AND PO RIVERS.

Author

B L Bakker

4571924

First mentor

Dr. D. Cannatella

Chair of Urban Data Science

Second mentor

Dr. L. Iuorio

Chair of Environmental Technology and Design

Delegate of the board of examiners

Ir. W.L.E.C. Meijers

Chair of Architectural Engineering + Technology

Delft University of Technology

Faculty of Architecture and the Built Environment

MSc Urbanism

Metropolitan Ecologies of Place studio

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Reimagining the Integration of Cultivation and Ecosystems

climate adaptation strategies for the rice production landscape of northern italy: the context of the ticino, sesia and po rivers.

Master Thesis required by the MSc Architecture, Urbanism and Built Sciences, Urbanism track.
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Delft University of Technology

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Figure 1.1: Bridge over drought-struck Orco river
Source: Amante, A. (2023c,)

PREFACE

Since the start of the Bachelors, my generation of aspiring designers has been confronted with the words that "we are the generation that needs to bring about change" regarding the current climate crisis. I shall not share my thoughts here about the pressure upon the shoulders of a generation;
however it has provided me with the ambition to work on subjects that deal with climate adaptation in urgent contexts and challenging environments. Additionally, the work has grown to cover a subject that has for a long time been on my mind, but which I have unable to adequately put into words or define: the human-nature relationship. Although it might capture one's imagination, it is also rather tenuous. This Master's thesis has helped me to capture its essence and through design, make it a comprehensible goal.
Hence, this work has become a direct result of my moral ambition to strive for positive change and climate action, combined with my passionate interest in Italian culture and territory.

RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

Figure 1.2: Drought-struck agricultural soil.
Source: Matthew, A. (2021)

ABSTRACT

In 2022, Europe experienced severe drought, notably affecting Northern Italy's Po region, renowned for its industrial and agricultural significance. Consequently, the region's food production sector encountered severe challenges in water management, struggling to meet its water requirements. Rice production, leading in the demand for water resources, is especially vulnerable to the evolving rainfall dynamics. Through research by design, this Master's thesis addresses improving water security for rice production while nurturing a symbiotic relationship between humans and nature. The research identifies conflicts arising from widely adopted dry-seeding techniques in rice farming and the abandonment of traditional water retention practices, exacerbated by climate change and leading to diminished water availability. The proposed design interventions seek to retain water in the landscape, replenishing aquifers, and prioritizing habitat restoration. This thesis suggests a paradigm shift in water management and agricultural perspectives, emphasizing the intrinsic link between water, human well-being, and ecological health. By integrating traditional flooded practices and ecological restoration into agricultural systems, it presents a holistic approach to water management. Additionally, the strategy stresses the importance of fostering awareness and active engagement with the natural environment to strengthen the human-nature connection. The insights gained from this study can inform future policies and practices, ensuring a sustainable and resilient future for the rice production landscapes of northern Italy and beyond.

CONTENT

Figure 1.3: Italian agricultural landscape.
Source: TeamSardinia,, 2024

1 INTRODUCTION

This paragraph will cover an introduction to the Master's thesis' subject, giving context and reasoning for the direction of the work.

Figure 1.4: Drought on the Po river.
Photograph by Francesca Volpi (Bertacche, 2022)

1.1 Context & motivation

In 2022, Europe experienced the worst drought since the 19th century, resulting in one of Europe's mightiest rivers flowing 30% lower than its previous most intense drought (Montanari, 2023). Conflicts regarding water management appear in the practical, technical, governmental and organizational spheres, making issues surrounding water management multifaceted, trans-scale and incredibly complex. On an institutional level, ambiguity hinders a long-term perspective and mismatching administrative and hydrological boundaries complicate proper action. Obscurity regarding responsibility for risk reduction for agricultural stakeholders prevents real change and emergency management begins acting only at the time of crisis, instead of taking adaptive measures (Musolino et al., 2018). Additionally, 20 to 40% of all transported water is lost due to failing infrastructure (Boyko et al., 2022b), since 25% of all water infrastructure is more than 50 years old (Waugh, 2024). The inadequate investments that have led to this, due to fragmentation within the industry, have constrained the potential use of recent technological advancements in water infrastructure (WRE Team, 2024).

Considering the devastating effects of the drought of 2022 on water security, which forced the government to invoke water conservation measures for its inhabitants, the system of water management is clearly not functioning accordingly.

1.2 Historical context

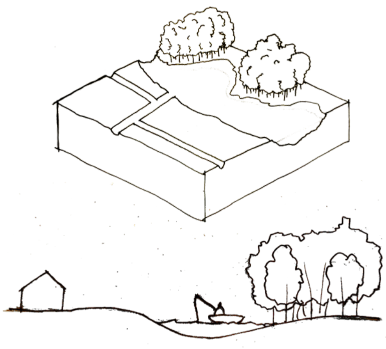
For ages, the Po river has been of paramount importance for Northern Italy, flowing from the Western Alps to the Adriatic sea, nourishing crops, fueling hydropower dams and launching the industrial development that made the Po river basin the economic heart of Italy it is today.
Historically, during times of heavy precipitation, the rivers overflowed their banks and drained into the neighbouring fields. Humans have attempted to control the dynamic flow of the river to protect themselves against flooding and provide suitable land for settlements and agricultural cultivation (Manieri, 2016).

However, the methods by which this was done transformed a key trait of the riverscape, its natural flexibility, to rigidity, weakening its ability to cope with natural flux (figure 1.5). This can be seen in the straightening of natural rivers, constraining them into small corridors only increasing their flood magnitude, or how flattening of the landscape for purposes of agriculture would guide water into towns instead. Nonetheless, the Po river is completely embanked, resulting in heightening of the riverbedding due to deposition of sediment and elevating it above the general topography of the plain. Finally, intense in-channel gravel extraction of the 20th century reduced sediment to such an extent that aggradation turned into erosion, wearing down channels and destabilizing engineering works (Guo & Montanari, 2023)

Over time, hydraulic projects only increased in size, further transforming the natural river to a constructed natural entity. One that has proven various times that it does not shackle without resistance. For example, repeated warnings from environmental organizations, including the World Wildlife Fund, highlighted the dangers posed by hydraulic projects along the Dora Baltea, but were ignored (Carroll, 2021), further intensifying the tragedy of its flooding in October of 2000. Deforestation, unregulated construction and inadequate drainage are instigators for the river crises that have occurred in the past.

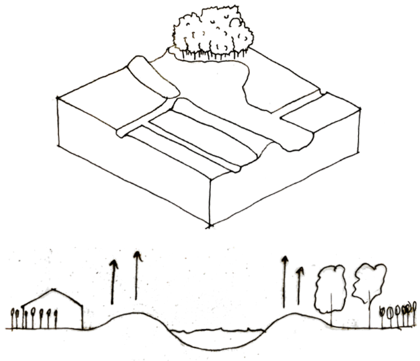
These methods of operationalizing the river started very early, leading back to the romans transforming their riverscape for purposes of water extraction and land reclamation. In Italy, watercourse management is characterized by a predominantly technical perspective that perceives rivers merely as “channels”, rather than holistic natural ecosystems. This approach prioritizes the utilitarian view of water as a “resource for people,” emphasizing human benefits derived from rivers, while neglecting their value as intricate, multi-dimensional bodies of natural resources (Manieri, 2016).

Furthermore, water is crucial for human health, food production, and the maintenance of various ecosystem services. To recognize the importance of water in the planet’s life-support systems, we must shift our perspective from viewing it solely as a resource, to an understanding of how water keeps the biosphere resilient for continuation of human development. To conclude, Manieri (2016) argues in line with Linton & Rockström (2010; 2014 as cited in Manieri, 2016), that to shift our focus from minimizing the effects of human activities, we need to aim at restoring the connection between humans and their environment.



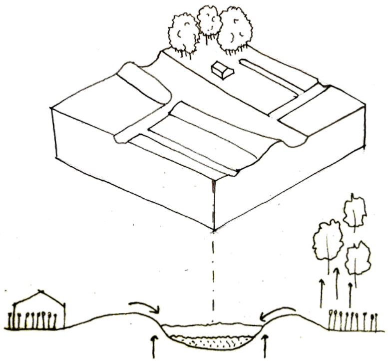
ROMAN

Water-husbandry, living to the boundaries provided by nature.



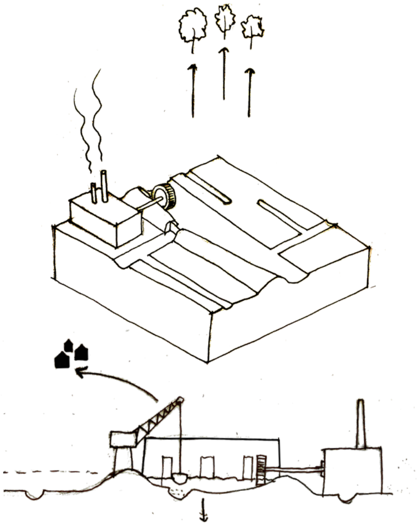
MEDIEVAL

Raising embankments for protection increases velocity and flood magnitude.



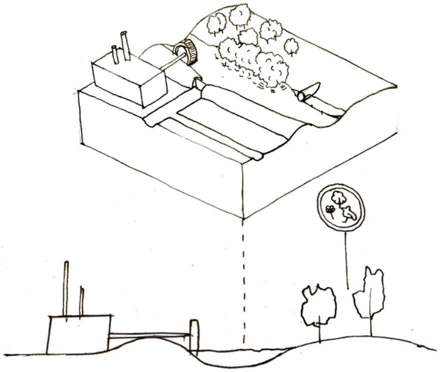
RENAISSANCE

Territorial control & economic dominance dictate ideologies for how rivers “ought to be” .



INDUSTRIALISATION

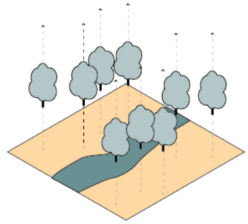
Deforestation and export of resources undermine traditional management.



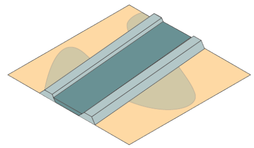
SEPERATION

Seperation between humans and nature.

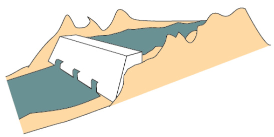
Figure 1.5: River control over the course of time.



Interrupting natural flow



River straigthening



Interrupting natural flow

Figure 1.6: Destabilizing methods of operationalisation.

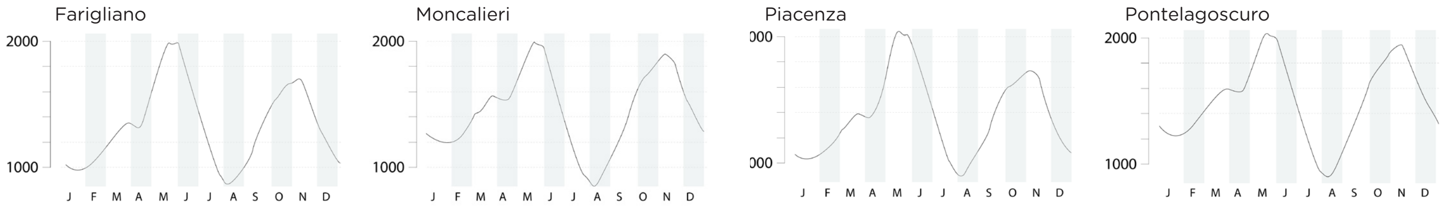


Figure 1.7: River discharge (m3/s) measured along the Po river, indicating the fluvial regime.
Source: Montanari, A. (2012) .

1.3 Hydrology

With 141 tributaries and stretching over 6750km, the Po river is among the largest rivers of the Mediterranean. Considering the intensity of cultivation taking place on its banks and the effects of its flow on neighbouring communities, its peaks and lows have been relatively well documented (Montanari, 2012). This chapter will dive into the the hydrological cycle of the of the Po river basin and how it is influenced by climate change.

The Po basin easily suffices in its water demand as it is conveniently located beneath the Alps in the North and the Apennines in the south. For the largest part, its hydrology is influenced by rainfall occurring in autumn and spring and meltwater from accumulated snow in the Alpine and Apennine regions (figure 1.7). Four lakes provide large natural storage capacity and collect runoff water from alpine catchments and have been artificially regulated since the 20th century. Together with some artificial reservoirs they function as important storage capacity for the Po river and its tributaries, providing water for the use of irrigation even when precipitation rates are lower, such as in the hot and dry summer that the Mediterranean is known for (Musolino et al., 2017).

The Po River has a distinct annual pattern, featuring two low-water periods during winter and summer, and two flood periods in fall and spring (figure 1.7). These fluctuations are heavily influenced by the seasonal distribution of precipitation. The initial flood period corresponds to increased rainfall in late autumn, while the second flood period is attributed to the runoff from snowmelt in the upper reaches of the watershed (Cattaneo et al., 2009; as cited in Zanchettin et al., 2008). Looking at the hydrological flux for the Po river basin, we can see that the groundwater resources are rather close to depletion (figure 1.10). This suggests that ensuring future availability of groundwater resources is going to be a challenge (Montanari, 2012).

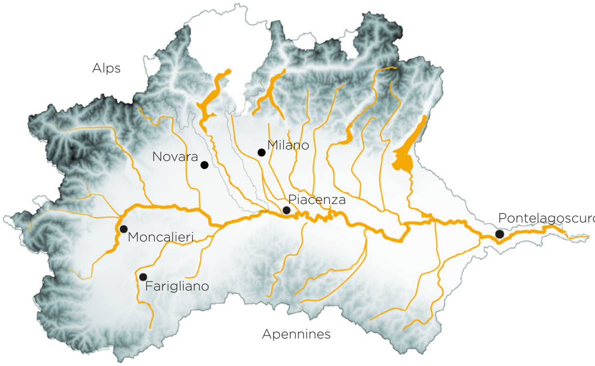


Figure 1.8: The course of the Po river and its main tributaries.
By author, from data available at NASA, 2023.

Figure 1.9: The Po Valley.
By author, from data available at NASA, 2023.

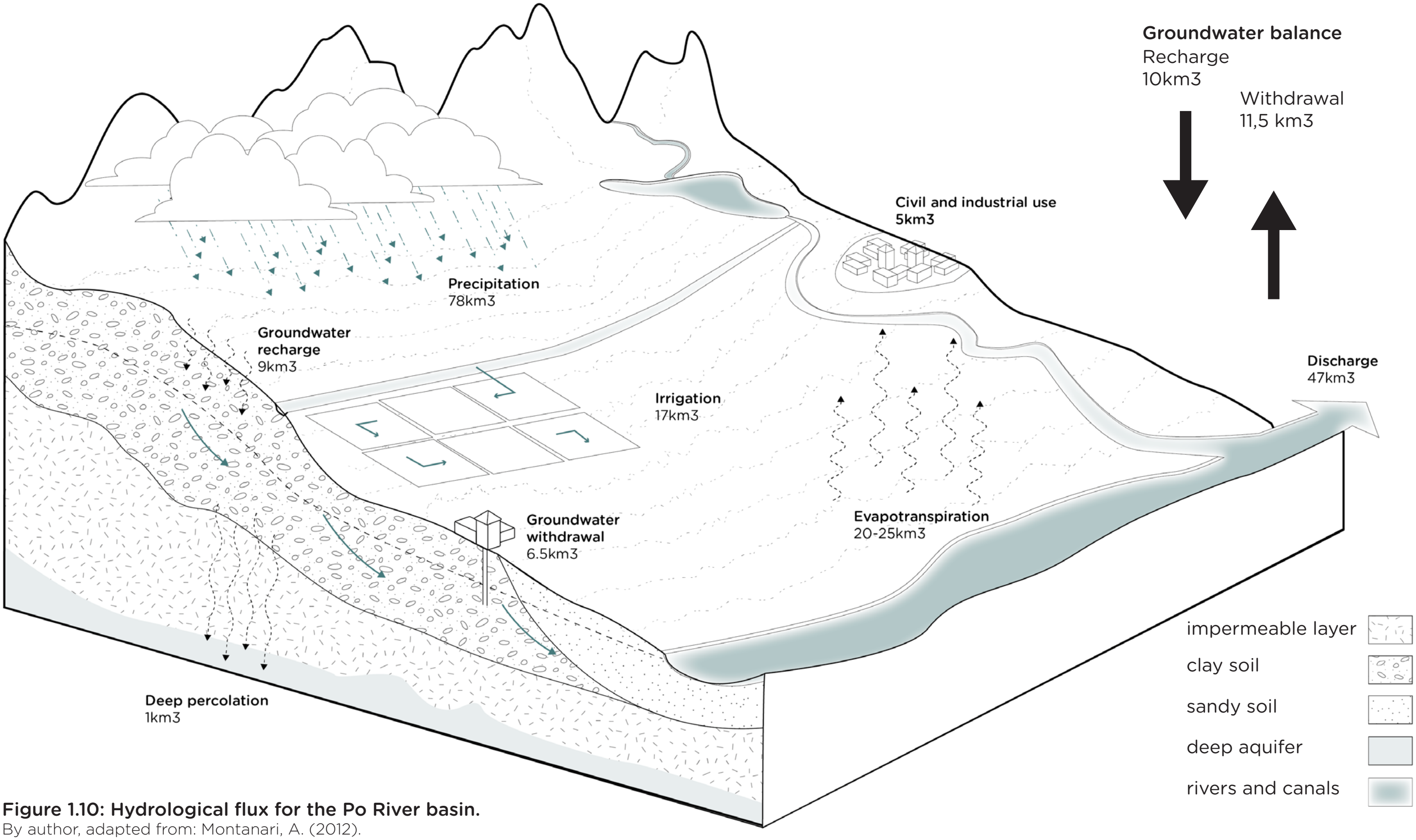


Figure 1.10: Hydrological flux for the Po River basin.
By author, adapted from: Montanari, A. (2012).

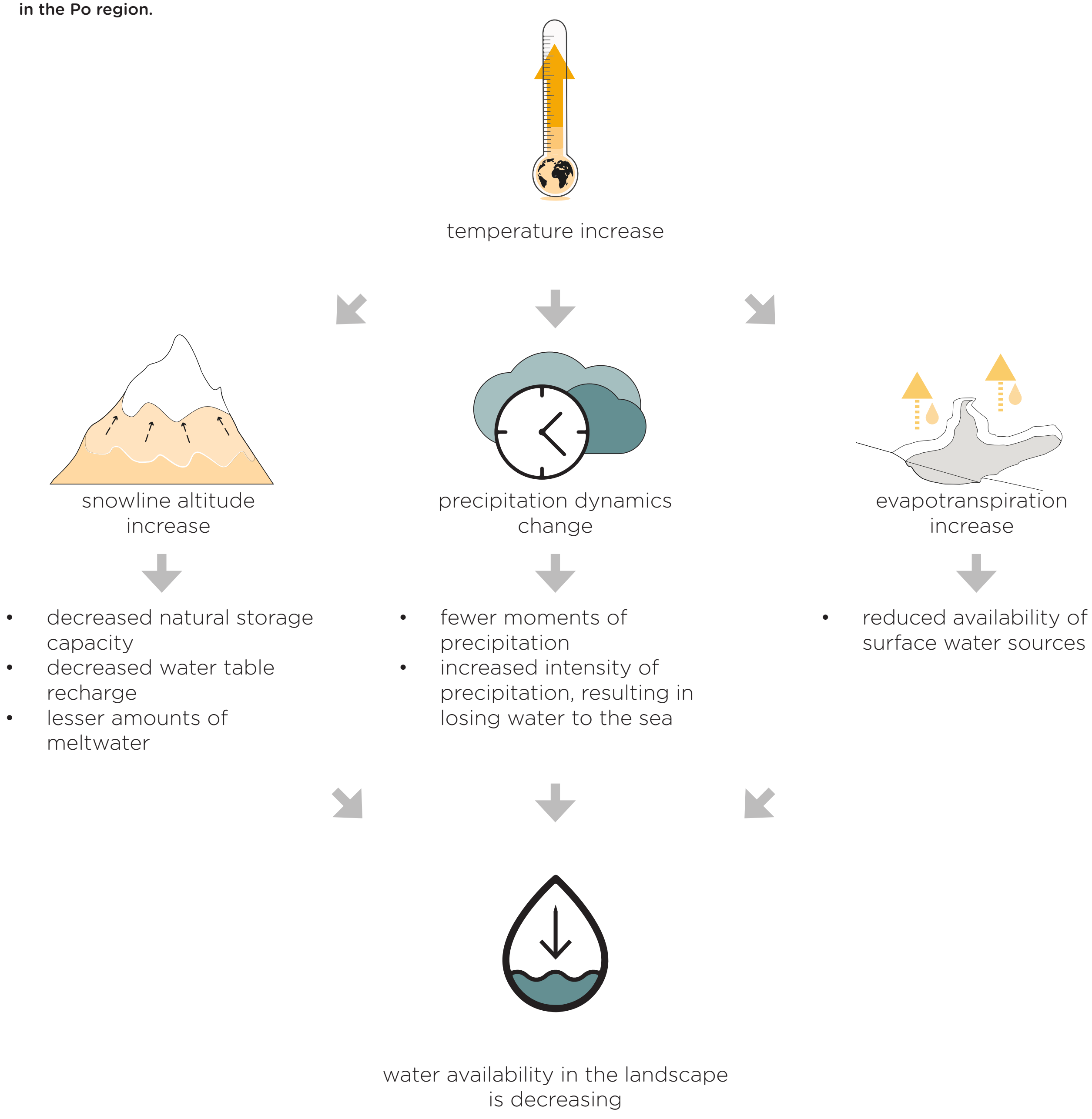
1.4 Climate change

However, the circumstances that provided the Po river basin with its water richness are changing. When in 1970 the temperature in Europe increased quicker than the mean land trend, the term global warming became a topic of conversation. Twenty years earlier however, meteorological droughts where already experienced more often in central and southeast Europe. Stagge et al. (2017) conclude that increases in temperature and therefore increase in rates of evapotranspiration have amplified the severity of droughts in Southern Europe. Higher rates of evapotranspiration reduce the availability of renewable water resources, increasing the demand for artificial irrigation to satisfy production.

Decreased winter precipitation, also as a result of higher temperatures, pushes the climatic snowline in the Alps and Apennines to higher altitudes, limiting the amount of water that they naturally store. Consequently, the effect of slowly recharging the water table is diminished, as well as the amount of runoff during the spring melting season. Additionally, less days of precipitation are observed during the year, while the intensity of precipitation during storms is actually increasing. This results in less water infiltrating the soil and instead being directed to the water system, which eventually discharges it into the sea.

From this we can conclude that although annually the amount of precipitation might not decrease severely, the timeframe in which it falls, changes. This reduces the availability of water resources substantially. Adaptation strategies are necessary that reflect a different way of water management than Italy uses right now. Methods of irrigation and crop choice need to be revised to fit to this new seasonality, aiming at water preservation and efficient use of available water resources (Boyko et al., 2022b).

Figure 1.11: Influence of climate change on water availability in the Po region.



1.5 Production

The decreased water availability discussed in the previous paragraph creates a risk for the water demanding industries that the Po region is known for. Its fertile soil in combination with water richness and strong communication routes have over time enhanced economic activities in the plain (SUWANU EUROPE, 2019), making the Po valley a highly enterprised area and the beating heart of Italy's industry and agriculture. It produces 40% of the national Gross Domestic Product by agriculture, cattle breeding, tourism and is home to a nearly a third of Italy's inhabitants (Frascaroli et al., 2020).

To sustain this level of production, water resources are overexploited for irrigation, hydro-power, civil and industrial use. Among these, agriculture has the highest water demand of all sectors (figure 1.12) with a withdrawal amount of approximately 17 billion m3 per year (Montanari, 2012). Crop production has by far the largest water footprint, requiring 53,032 Mm3/year.

Looking at the water requirements for crops produced in the Po region (figure 1.12), we observe that half is composed by rice production, while we can see in figure 1.14 that rice production covers a portion of the Po region much smaller compared non-irrigated arable land. This is due to the method of rice production requiring large amounts of water to sustain flooding techniques and provide the right circumstances for rice growth (Mekonnen, M., & Hoekstra, A. Y., 2011).

Given that half of the world's population consumes rice daily, and it contributes more to the world's dietary energy than wheat and maize (20% compared to 19% and 5%, respectively), rice is considered one of the most strategically important commodities globally. Additionally, Italy produces 50% of all rice consumed in Europe (Agriculture and Rural Development, n.d.). However, both research and production face challenges as yields remain stagnant despite increasing global demand. Furthermore, the impacts of climate change are expected to further complicate rice productivity as freshwater resources diminish globally (Rahman & Zhang, 2022).

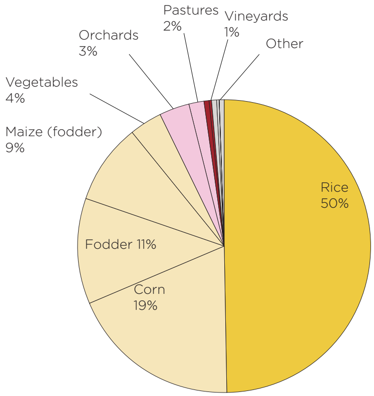


Figure 1.12: Water footprint of crop production per crop.
By author, based on Mekonnen, M., & Hoekstra, A. Y. (2011b).

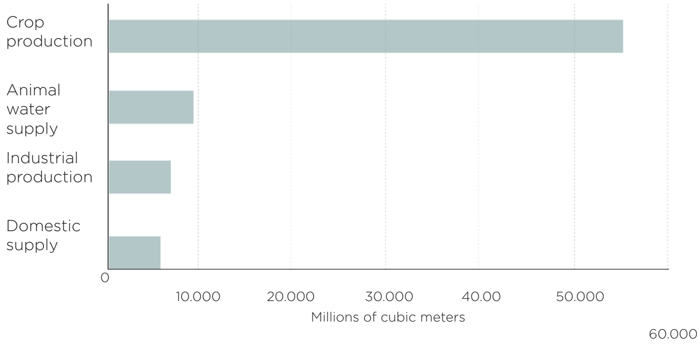


Figure 1.13: Water footprint of production by source and sector.
Source: Antonelli, M., & Greco, F. (2014).

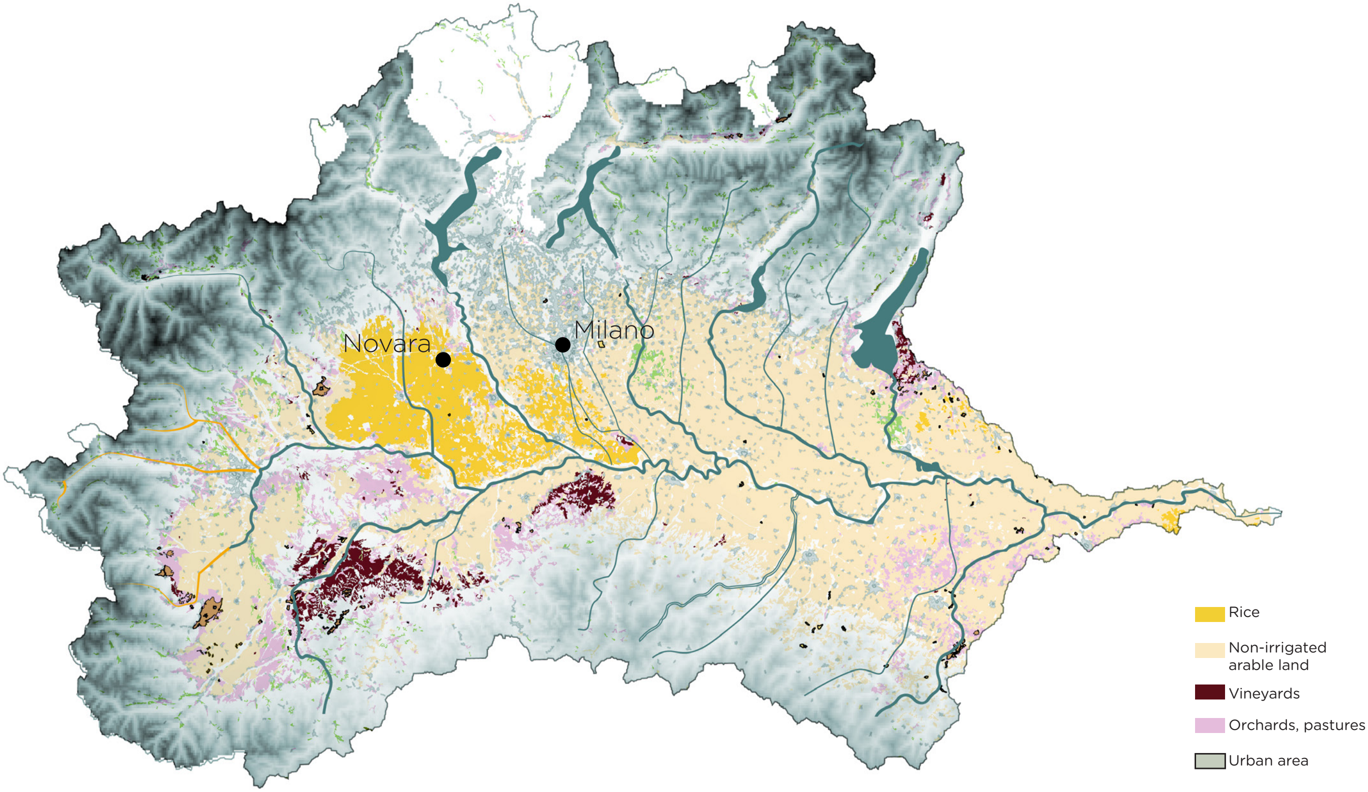


Figure 1.14: Agricultural landcover of the Po river basin.
By author, from data published by Copernicus & Land Monitoring Service.

1.6 Problem Statement

Problem statement:

Society currently adheres to a flawed perspective that views nature merely as a resource to exploit, neglecting its intrinsic value and affecting its natural resilience (Manieri, 2016). This mindset is perilous, especially as climate change exacerbates the challenge of ensuring future availability of essential resources. In Italy's Po region, the availability of one these essential resources, water, is declining due to changing climate patterns (Boyko et al., 2022). Its scarcity poses a significant threat to agricultural production, particularly for water-intensive crops like rice (WWF's study: Water Footprint of Italy, z.d.). If water requirements are not met, the production of such staple foods could falter, jeopardizing food security.

Objective:

According to the problem statement and considering the approach of research by design, the main objective of the thesis becomes:

By means of design, provide water security for food production

Hypothesis

Paragraph 1.2 concludes that we have to recognize the importance of water in the planet's life-support systems to ensure its future availability. To do this, a shift in perspective is necessary from viewing water solely as a resource, to an understanding of *how water keeps the biosphere resilient for continuation of human development*. This can be achieved by restoring the connection between humans and their environment. To improve this connection, the project proposes that water management should be revised in a way that is considerate of nature, allowing me to pose the hypothesis as follows:

Water management can be improved in a manner that is considerate of nature. This allows for meeting nutritional demands through the preservation of rice, by maintaining ecosystem services and improving the connection between humans and nature.

Paradigm case

The Po region's rice production is concentrated in the regions of Lombardia and Piemonte. To provide the research with a paradigm case, it will take the area between the river Ticino, Po and Sesia as its constraints. Since the Ticino is one of the main tributaries of the Po river and Europe's first river park, the relationships between the natural and cultural landscapes and their ecological values and services provide an interesting case for fostering an improved connection between humans and nature.

Research Question

Combining the core problem, the objective, hypothesis and the paradigm case, the resulting research question becomes:

How to enhance water security for rice production fitting to evolving water dynamics, while improving the connection between humans and nature in the paradigm case of the Ticino, Sesia and Po river.

The research will attempt to answer this in two parts;

How does rice production interact with and alter natural processes and landscapes?

How does climate change impact the hydrological system of the region and the different processes related to rice production?


CANALE CAVOUR

Figure 2.1: Inlet of the Cavour channel.
Source: Panarella, 2019.

2 Methodology

The following paragraph will delve into the methodoly of the work, including the research strategy, methodological framework and theoretical framework. These contain information on the structure of the work, the approach of the project, the research- and designquestions and the theoretical sources that the research taps into. These provide the necessary fundaments of the project.

2.1 Research strategy

First of all, the project makes predominant use of research by and through design. Therefore, through use of design principles, the research informs the design. By concluding upon the design, its implications for transferability are defined. Finally, after elaborating on the final considerations, a reflection of the social, ethical and scientific elements is included, elaborating on the motivation for certain positions taken.

Next to that, as belongs to system-thinking, the graduation work will cover and interlink different scales. The research covers the scale of the full river system, the Po river basin, through which it zooms into the regional paradigm case between the river Sesia, Ticino and Po. By concluding, implication for transferability on a larger scale are discussed, followed by a reflection on the position of the design in the bigger context.

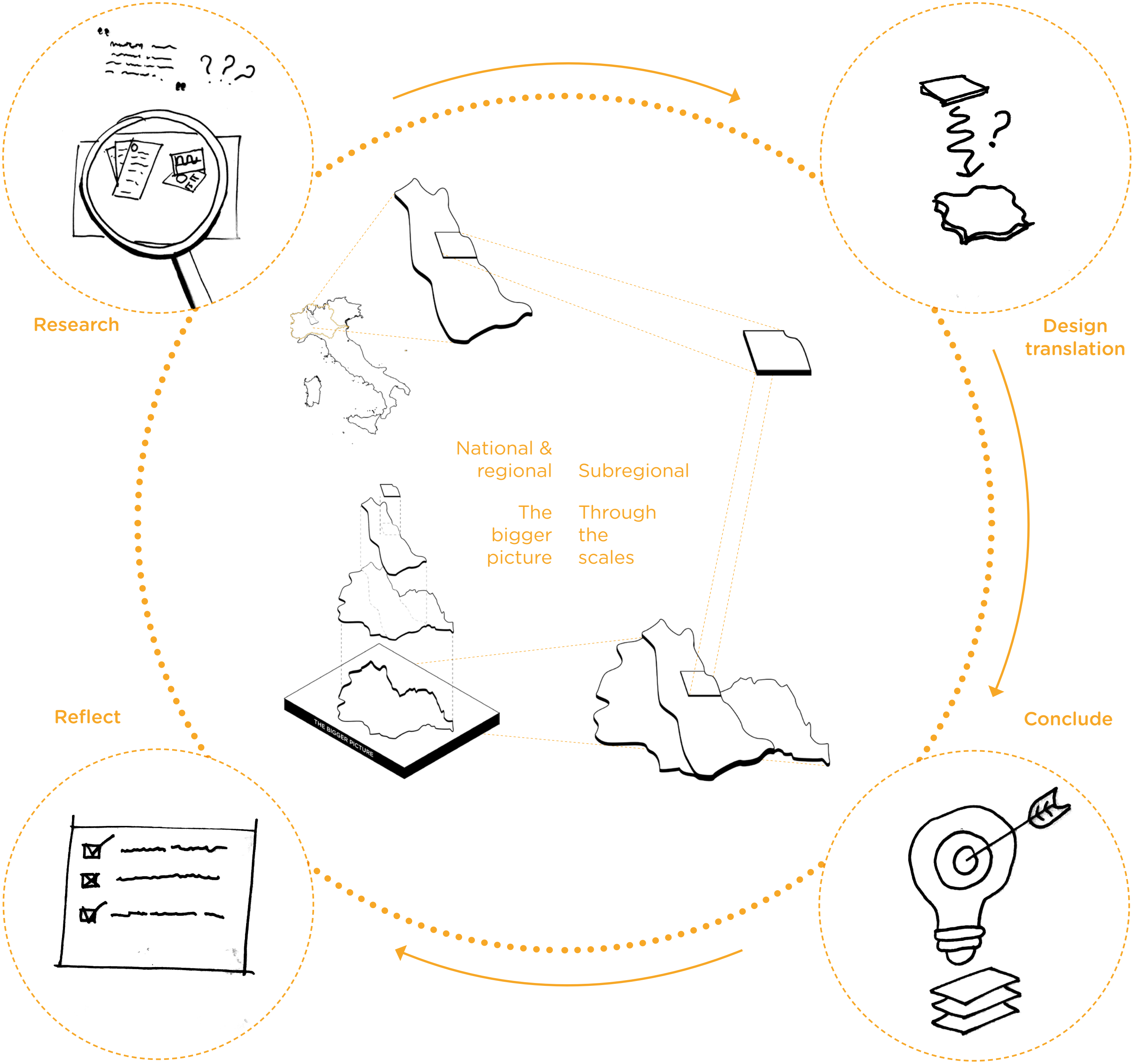


Figure 2.1: Research strategy

2.2 Methodological framework

Research question
How to provide water security for rice production fitting to evolving water dynamics, while improving the connection between humans and nature in the paradigm case of the Ticino, Sesia and Po river?

Design question
How can design reinforce habitat provision in agriculture, enhance water security and improve the human-nature relationship in the urban rural context of Novara?

subquestions

What are the characteristics of the regions hydrological system?

Literature review | Historical analysis | Critical mapping | Interviews

How does rice production relate to territorial qualities?

Literature review | Historical analysis | Critical mapping

What environmental challenges are prevalent in the region?

Literature review | Critical mapping

What is the role of rice production in the regions landscape transformation?

Literature review | Historical analysis | Critical mapping

subquestions

What are the specific socio-economic and environmental challenges faced by the landscape Novara?

Literature review | Research by design

What agricultural practices are most effective in promoting biodiversity and can be integrated with rice production in the specific context of Novara?

Spatial analysis | Research by design

Which interventions can retain water in the landscape and simultaneously strengthen habitat provision?

Spatial analysis | Research by design

How can urban planning incorporate elements that promote a harmonious human-nature relationship?

Literature review | Spatial analysis | Research by design

Conclusion
How can the strategy be transferred to different locations and larger scales?

Reflection
The social, ethical and scientific reflection on the process, the outcome and the considerations that have been made.

subquestions

To what extent do the research and design address the territorial challenges and lead to qualitative improvement?

Strategy assessment | Qualitative comparison

What are the challenges and competitions in transferability of the design strategy?

Strategy assessment | Literature review

subquestions

How does the aim of tis work align with the objectives of the mastertrack and graduation studio?

Reflection

How has the research informed the design?

Reflection

What ethical issues are addressed in this research?

Reflection

What is the societal, academic, political and economical relevance of this project?

Reflection

2.3. Theoretical framework

Landscape Urbanism

Landscape urbanism aims to use processes and structures of the natural landscape as a starting point to generate urban habitats with deeply integrated social and ecological themes. It helps cities grow smarter by developing resilient landscape structures and tapping into nature and society for clever solutions to urban challenges. Meanwhile, it highlights the importance of which natural and cultural elements should remain intact. The method involves understanding the landscape from a system perspective, which entails understanding it as a space made through structures and processes of human and nature interaction, and especially viewing it through the lens of time.

A method that is home to landscape urbanism, which is used in this project, is research through design, as a means to explore possibilities of designing with nature, water sensitive design and social-inclusive design. This is done in by working through different scales and facilitating differing measures, either general or specific, relating to the specific context they are applied to. (Nijhuis, 2022).

Adaptation

Due to high levels of uncertainty, it is hard to predict when exactly events will happen that disrupt the established order in urban and natural territories alike. However, by planning adaptively and anticipate extreme weather events, overall risk and potential recovery time can be reduced (National Research Council, 2012, as cited in Berke & Stevens, 2016). In this way, development can be planned in a way that minimalizes potential vulnerability and ensure safety.

Additionally, the European Commission has stressed the importance of taking immediate action in building more resilient. Since in 2021, the hottest decade was measured in which eight years were proclaimed 'hottest year'.
The "Forging a climate-resilient Europe" report (European commission, 2021), emphasizes how events of climate extremes are occuring more often, contributing to destructive effects trends as desertification, ecosystem degradation and loss of biodiversity. To combat this, the EU has dedicated itself to the long term vision of becoming a climate-resilient society by 2050, further highlighting the importance of projects that deal adaptively with climate change. This project devises a strategy for the same goal, adapting to the changing climatic circumstances and providing an alternative that can cope with and potentially even counteract their destructive effects.

Operationalised Landscape

The term 'the operational landscape (Brenner, N., Katsikis, N., 2020) is used to, according to the theory it represents, frame a perspective of the riverscape as a constructed natural landscape, both an instrument of exploitation as an ecological entity. This view is further substantiated by fleshing out the connection between humans and nature that lies beneath:

According to Latour (1993, as cited in Manieri, 2016), the modern era nudges us to forget that we played a fundamental role in the production of environments and ecologies to be able to produce for ourselves. They use the term hybridity to pinpoint problematic of the modern understanding that nature and society are separate antities. Jamie Linton in '*What is water'* (2010, as cited in Manieri, 2016) states how "water is what we make of it.", further emphasizing how the two cannot be viewed inherently separate.
Manieri (2016) suggests how understanding this separation between humans and nature through comprehending people's perception of themselves in nature is fundamental in in its relation to human-environment interaction and management. They argue that although it might be hard to make people change their perspective of nature, making people more aware about their views of nature could nudge them into conscious thought and action. Therefore, encouraging people to engage with nature can raise awareness about the deteriorating state of the environment, which ideally would inspire them to make environmentally considerate choices.

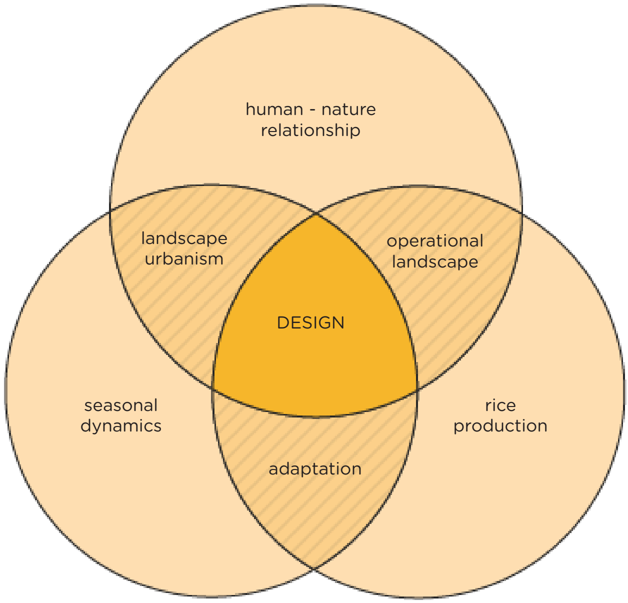


Figure 2.2: Theoretical framework.

They further elaborate that the concern of people in developed countries over land management is highly influenced by their feelings towards that place. The places that people often hold in high regard are natural, tranquil and generally considered to be places where one can immerse themselves in nature. Addressing the feeling towards natural areas may aid winning those over who would otherwise have little interesting in land management issues.

Figure 3.1: The Ticino river.
Source: Chameleon, 2023.

3 Tales of a territory

The following chapter contains the body of research into the paradigm case; the Ticino, Sesia and Po rivers. First, a territorial analysis is provided that covers the properties and challenges of the region, which conclude in a synthesis map. The second part of the paragraph covers how rice production has been a driving force for landscape transformation and concludes by providing the guiding principles for the design strategy.

3.1. Territorial analysis

3.1.1 System of wetness of the rice production landscape

Since the introduction stressed the importance of water availabiliity for rice production, the research attempts to understand the territtory through the lens of the hydrological system. The hydrological system of the region has been intricately shaped over the decades. As was shown in paragraph 1.3, water comes down from the Alps and Apennines and flows through greater rivers and smaller streams and channels to the Po, transporting it to the Adriatic sea (figure 3.1.1). Where the river Sesia starts in the mountains as a small river and directly flows into the Po, the Ticino river has its source in the Swiss Alps, after which it flows through one of the great natural water reservoirs of Italy: Lago Maggiore. The outflow of the lake is controlled at the Miorina dam before it continues its way down through the Ticino river park, branching into a couple directions (figure 3.1.2)

This set of artificial canals transport water from the Ticino river into the hinterlands on both the Lombardian side (Villoresi canal) and the Piemontese side (Regina Elena canal) for purposes of irrigation, navigation and energy production. The volume of the Ticino river is mainly controlled at the Miorina dam, to such an extent that the level in Lago Maggiore stays elevated enough to fulfill its function as reservoir and tourist attraction (in relation to certain beaches) and that its outflow is just enough for the canals that are connected to its stream and the preservation of the delicate ecosystem along the riverbank (Salmaso et al., 2021). Most importantly, the agricultural production rate was highly improved by the introduction of an intricate network of canals which introduced water from the Po into the hinterlands. The Cavour channel, starting from upper Po river and feeding into the Ticino was the pinnacle of these works in 1866 (Piano Paesaggistico Regionale, 2017). Artificial channels birth from the Cavour channel that, next to the natural rivers, nourish the agricultural landscape (figure 3.1.3)

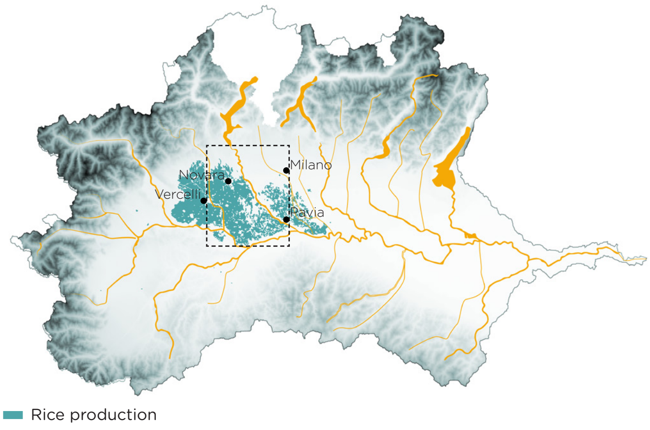


Figure 3.1: The paradigm case of the Ticino, Sesia and Po.
By author, from data available at NASA, 2023.

Figure 3.2: Hydrological system.
By author, from data available at NASA, 2023.

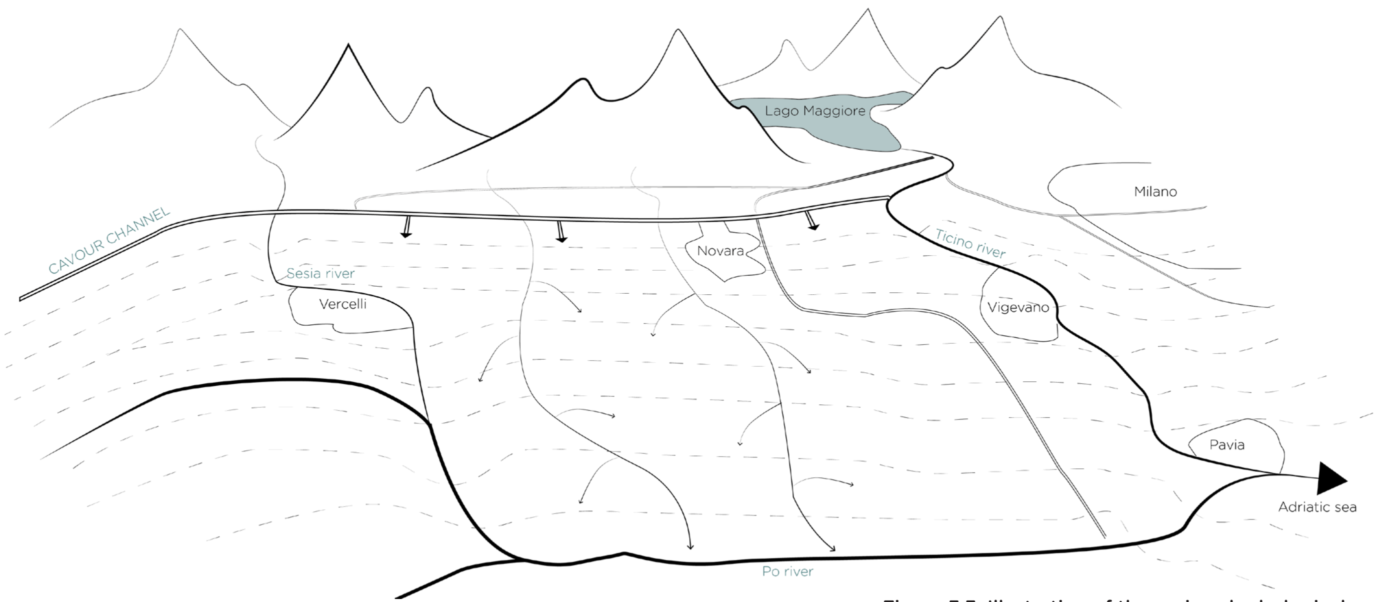


Figure 3.3: Illustration of the regions hydrological system.

3.1.2 Characteristics of nature within the rice production landscape

The first kilometers, the river follows a unicursal path defined by the orography of the landscape (4, 8). After 30km its bedding widens with islands of gravel, forested oxbow lakes where the river previously flowed and many natural qualities that slow down the river, additionally functioning as buffer zone in times of flooding.
These qualities have been protected since 1974 and shield the river's natural environments from the threat of increasing urbanization. To preserve its biodiversity, the park dictates three zones of regulation based on proximity to the river; prohibition of agriculture, naturalistic governance & preservation of habitat and finally, the encouragement of sustainable measures (figure 3.6). To combine the environmental needs for protection with social-economic demands of its inhabitants, it encompasses kilometers of cycle and pedestrian paths that provide important touristical benefits to the region (Ente di Gestione delle Aree Protette del Ticino e del Lago Maggiore, z.d.).

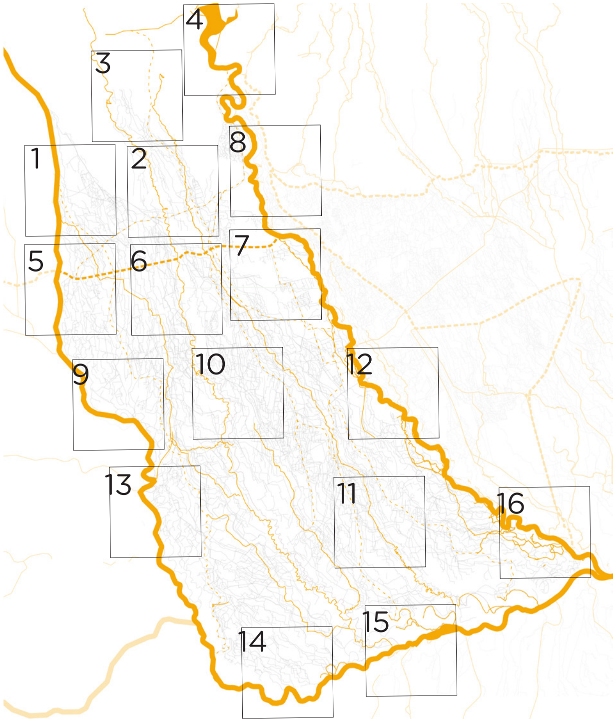


Figure 3.4: Locations of landscape characteristics.

RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

3.1.3 Territorial analysis of the rice production landscape

The Po valley, and even more the river valleys, have loose soils with abundance of sands, gravels and pebbles; soils that due to their porosity are optimal for the development of roots and cultivated plants but do not retain rainwater or irrigate. Therefore, they to be watered frequently not to dry up and become dust, like in spring with strong winds or in summer when the soil not yet covered with crops. The sandy soil in or along places where rivers flow or have flowed, is largely alternated by loamy soil with patches of clay. As we can see, the soil type is often an indicator for crop types and agricultural methods (Bove et al., 2016)

The lands beneath the Canale Cavour have a near constant availability of water while the lands above are dependend on direct rain- or meltwater from the mountains. Since this water is also colder it can only be used for agriculture directly later in the year, when the temperatures are higher, or when water has circulated in fields for a while to obtain the right temperature.

Drought anomalies (figure 3.1.7) seem to indicate a slight increase higher up in the basin, comparable to how soil moisture deficit seems to be more frequent in more allevated areas.

Soil moisture deficits seems to decrease the lower in the basin, which would make sense considering water travels through sandy soil and collects at the lowest point.

Figure 3.5: Agricultural restrictions.
By author, adapted from Parco Lombardo della Valle del Ticino, 2024.

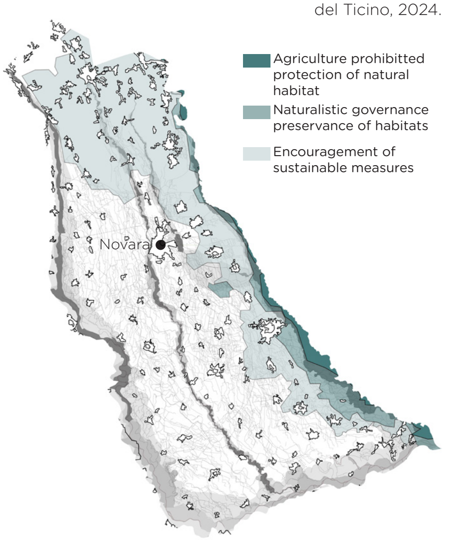


Figure 3.6: Landcover.
By author, from data published by Copernicus & Land Monitoring Service, 2023.

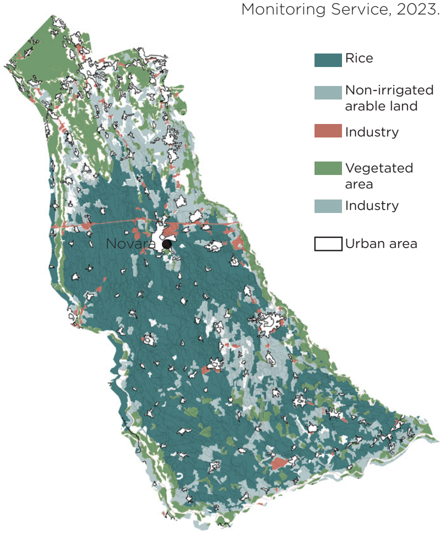


Figure 3.7: Drought anomalies 2018-2024.
Source: Europen Drought Observatory, Copernicus, 2024.

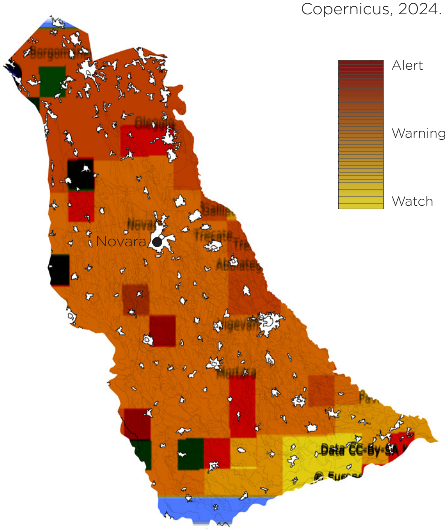


Figure 3.8: Floodplains & hazard.
By author, from data published by Autorità di Bacino Distrettuale del Fiume Po, 2019.

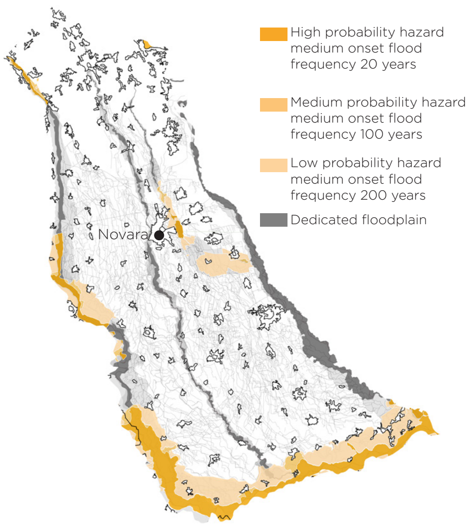


Figure 3.9: Soil.
By author, from data published by Regione Lombardia, ERSAF, 2024, and Geoportale Piemonte, 2024.

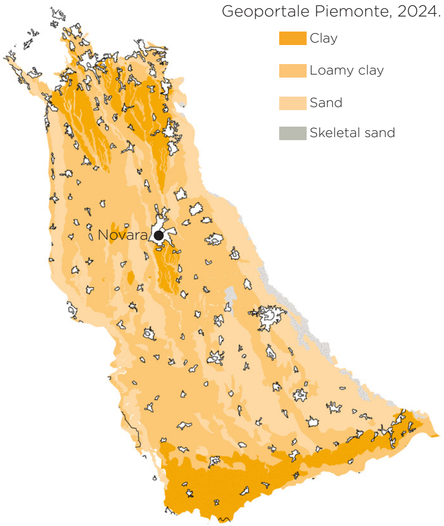
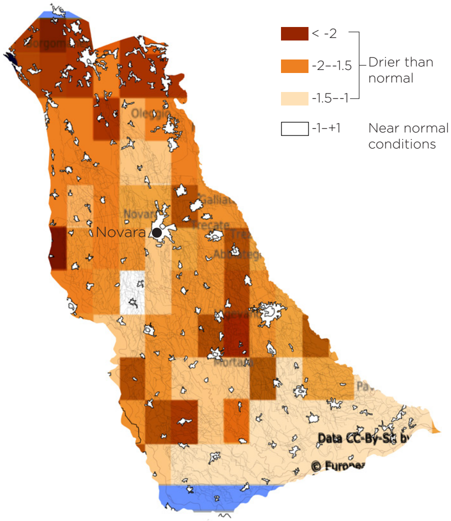


Figure 3.10: Soil moisture deficit.
Source: Europen Drought Observatory, Copernicus, 2024.



3.1.4 Synthesis

The research suggests that soil is an indicator for both rice production as drought anomalies. The reason for rice production to take place predominantly on loamy clay and clay soil has to do with the water retaining qualities of these soils. This will be elaborated upon in the next paragraphs.

The combined drought indicator extrapolated over six years time suggests recurring drought anomalies over sandy soil. This could be to sandy soil holding water less well and therefore being more vulnerable for increased evaporation rates. Soil moisture deficits are harder to link and the inacuraccy of these “fields” has to be taken into account, making it questionable whether drought anomalies and soil moisture deficits have a causal relationship. Nonetheless, the knowledge of recurring temperature anomalies and soil moisture deficits can and will be taken into account in the design part.

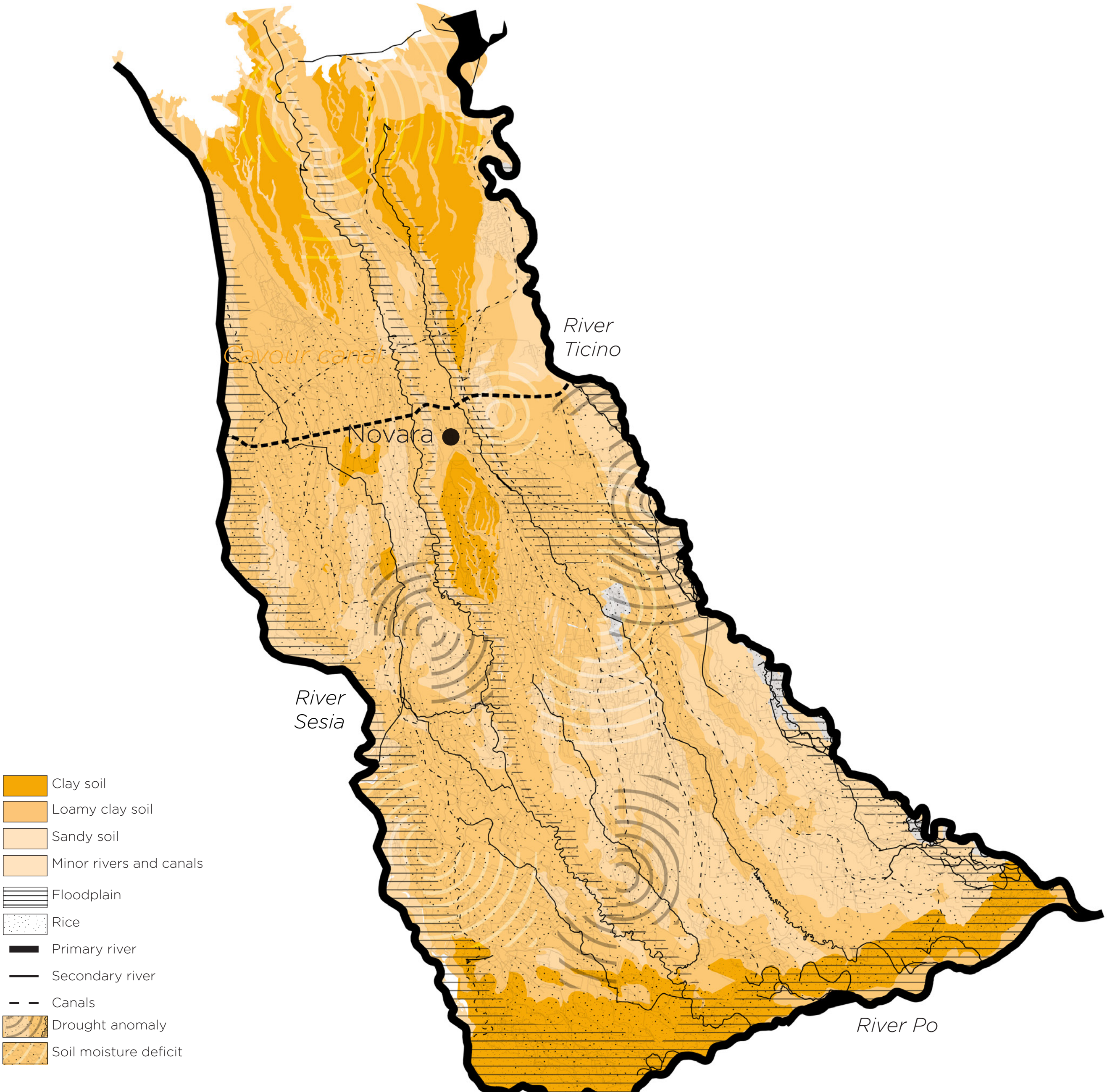
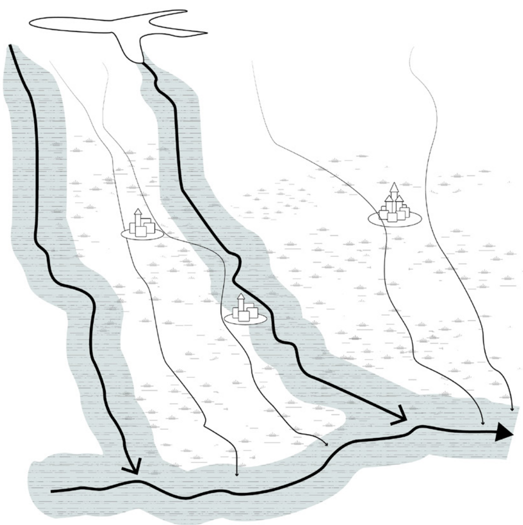


Figure 3.11: Synthesis.
By author, from data published by Autorità di Bacino Distrettuale del Fiume Po, 2019) & Copernicus & Land Monitoring Service, 2023 & Regione Lombardia & ERSAF (2024) & Geoportale Piemonte (2024).

3.2 Rice as a driving force for landscape transformation

3.2.1 History of rice



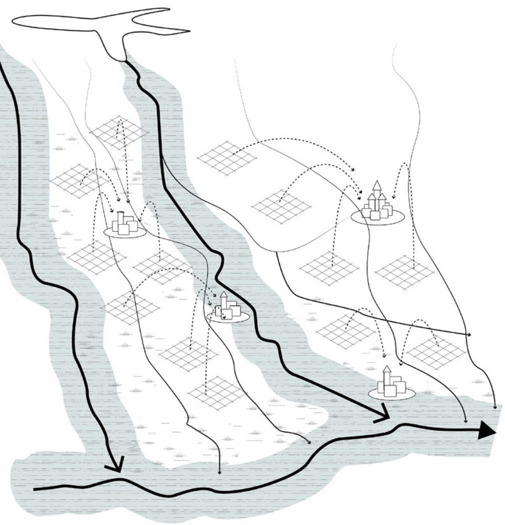


Figure 3.12-3.15: Historic landscape transformation.

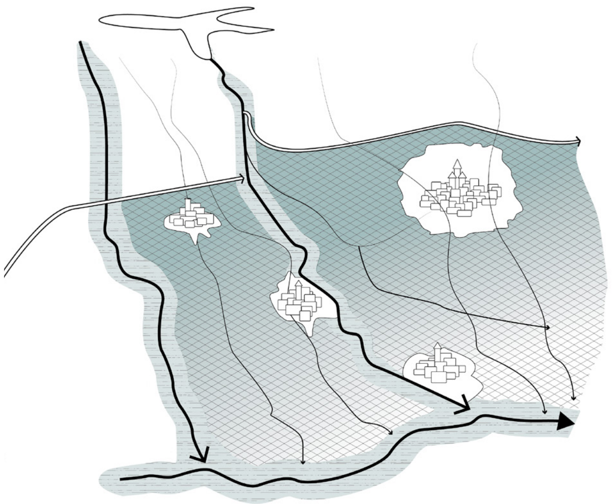
1 Establishment

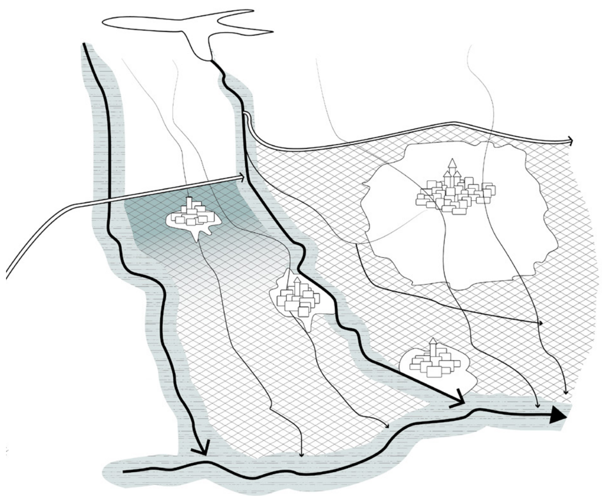
The territory of Piemonte, characterized by sand and clay soil, was shaped by the yet untamed and frequently flooding rivers into a swampy landscape. To reclaim the land and turn it into farmland, rice was introduced at the end of the 15th century by Cistercian monks and used as a crop for medicine. The stagnant water of the swamps, however, provided an ideal habitat for swarms of malaria-spreading mosquitoes. This factor, among others, made the initial attempts at establishing rice farmland fraught with hygiene and health issues for those working in or living near the rice fields. Despite probihition by law to grow rice in a range of 16km of residential areas, the expansion of rice was unhalted as the ever growing population encountered food scarcity and was in need of a highly productive crop.

2 Refinement

To intensify rice production, two key measures were necessary: sustaining a constant water supply to keep the rice submerged and reducing the mosquito population to address the health complications associated with rice cultivation. To this end, an intricate network of canals was built, of which canale Cavour forms the pinnacle of all works, taking water from upstream of the Po river and transporting it, eventually, to the river Ticino.

By following the orography of the landscape, it takes water in a direction contradictory to that of natural rivers and allows for near constant irrigation of the lands beneath (Rolando & Scandiffio, 2021b). Thanks to this, the fields could be levelled in such a way that the water flows constantly with a very slow rate, making it less appealing for swarms of mosquitoes.





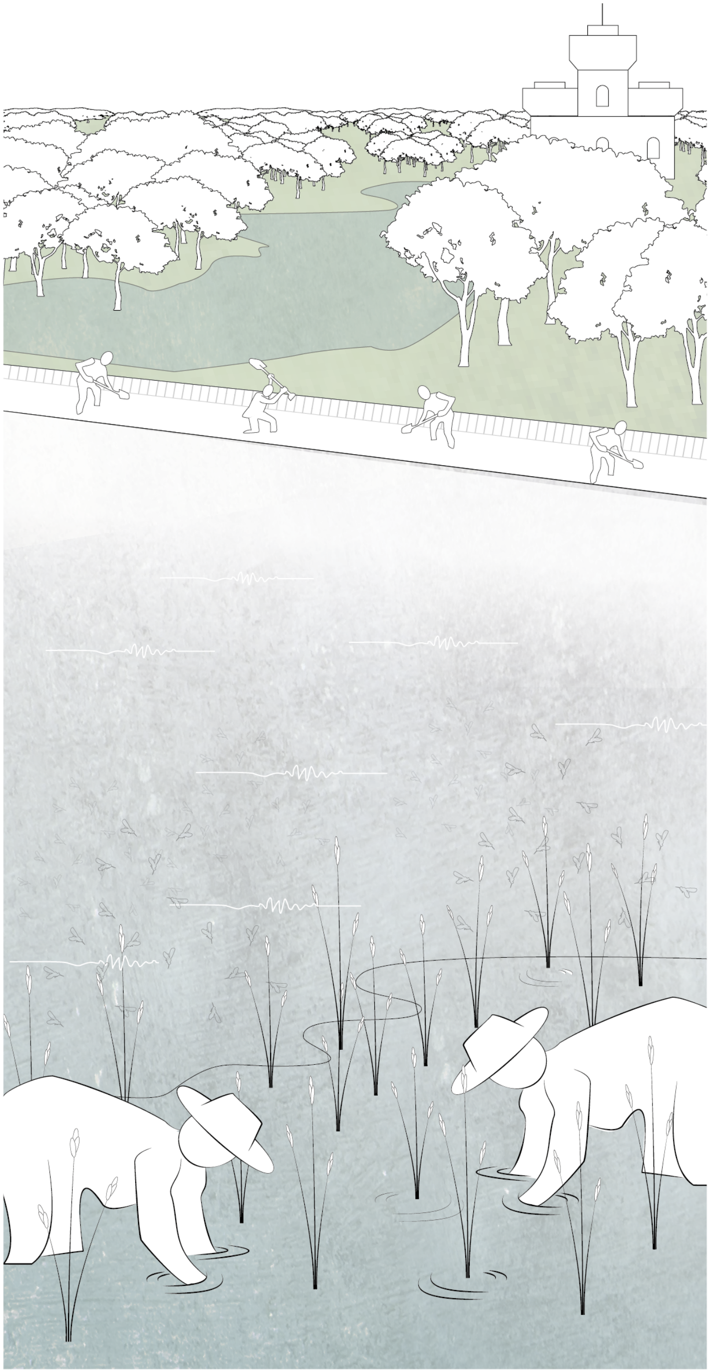
3 Industrialisation

Rice production spread even more quickly throughout the landscape due to the industrial revolution and the introduction of herbicides, pesticides and machinic agriculture. New agricultural methods emerged in the 1950's that reduced labour and costs while increasing yield. These methods assisted in forming the widely known "checkered landscape" of flooded rice paddies. However, due to further in- and extensification of agriculture, natural landscapes and vegetation within agriculture started to disappear.

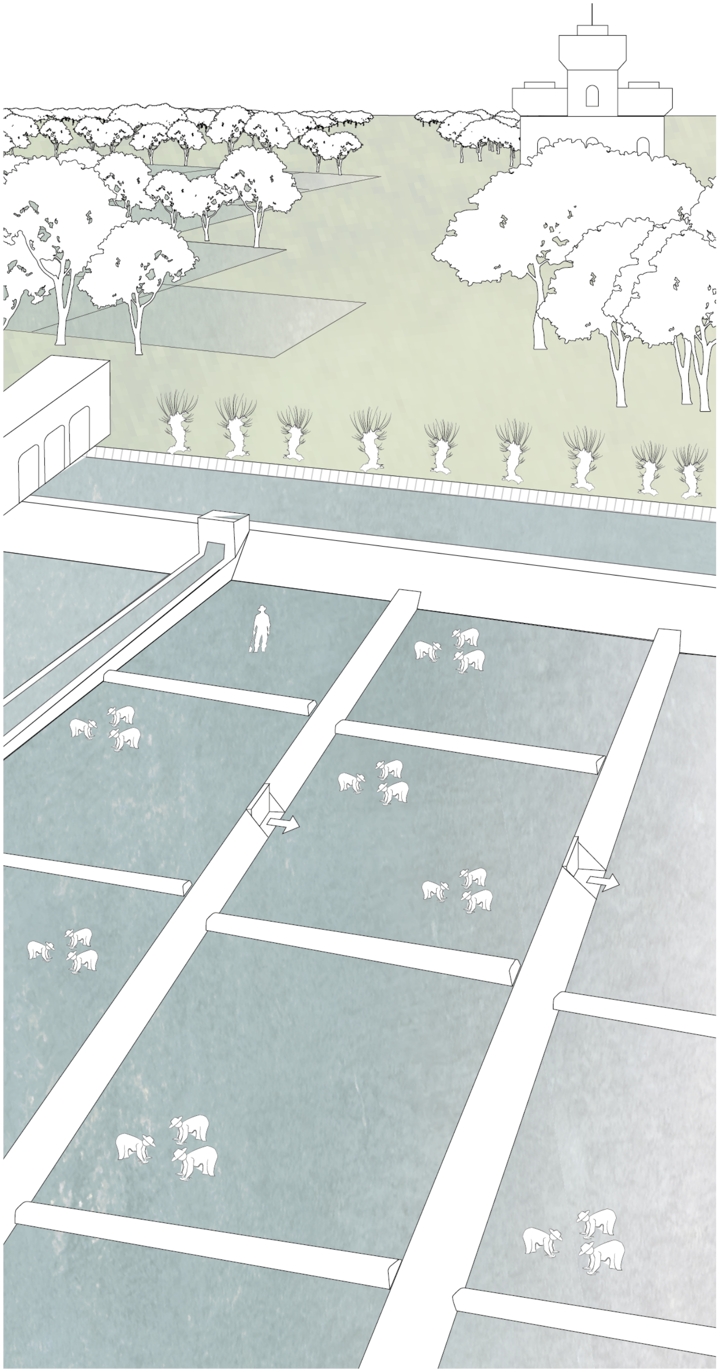
4 Contemplation

Near the end of the 20th century, one of these methods that reduced labour and costs was the practice of dry seeded rice with delayed flooding. It is described as a method that needs less water, alleviating the costs of water and equipment and having a more efficient sowing phase. In all actuality, it requires water in a different timespan than the traditional method and has since its introduction been adopted to such an extent that only 20-30% of all the regions' rice production is still grown the traditional way (Bove, 2021). In the same period of time, the resource on which the whole system depends (water) started to diminish, resulting in droughts and yield losses. Researchers and farmers question whether these are solely the effects of climate change or if the large scale transition to a method that adheres to different water dynamics plays a role (Monaco et al., 2016). The following paragraphs will delve into this matter. The images on the next page visualise the transformation of the rice production landscape according to the same four stages.

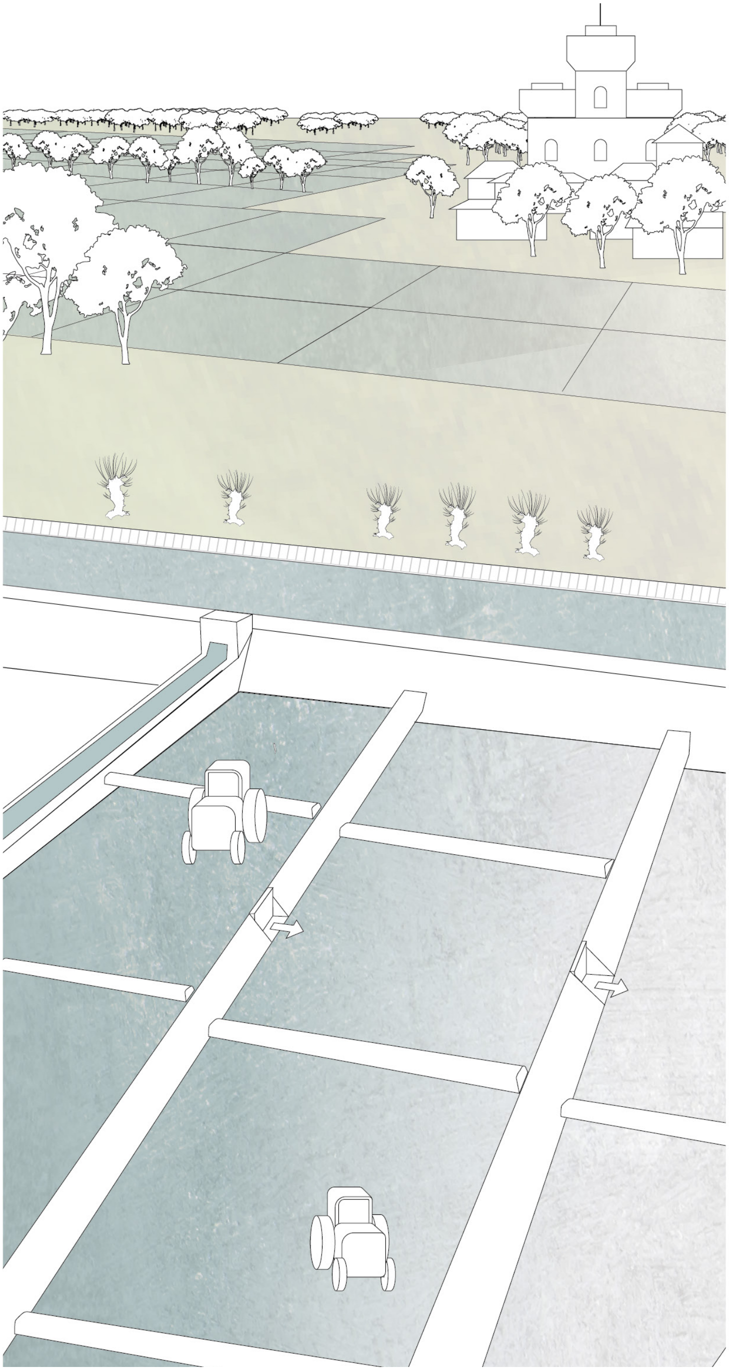
1 Establishment



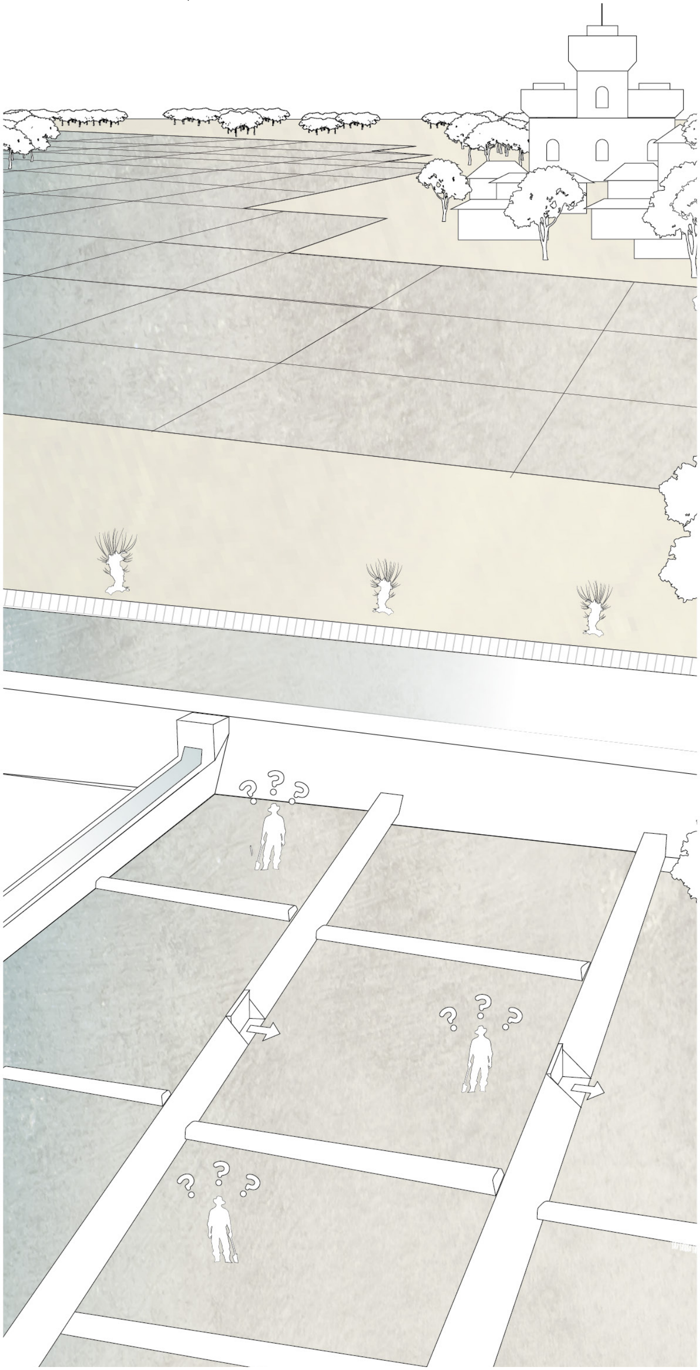
2 Refinement



3 Industrialisation



4 Contemplation



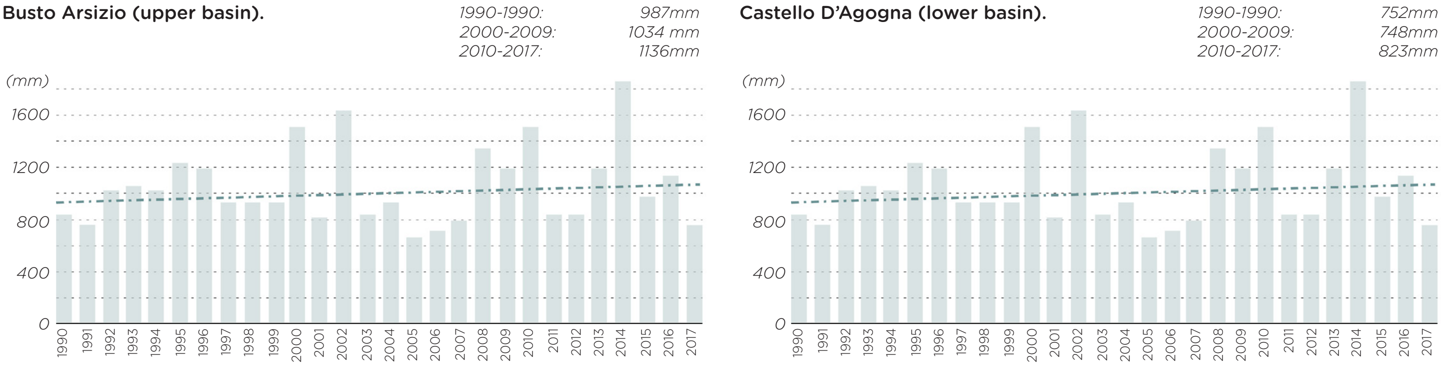


Figure 3.22: Precipitation over time compared to lower and higher in the basin.
Source: By author, adapted from ARPA Lombardia in Bove & Ente Nazionale Risi (2021).

3.2.2 Water dynamics and climate change

The water system can be considered as rice's core infrastructure and is heavily influenced by seasonal dynamics, therefore so is rice. In fall and winter there is plenty of water as the demand is low and precipitation is high. Water is even considered to be 'abundant'. Still, traditional techniques like winter circulation, (circulating water in the uncultivated fields and canals in winter and spring) were used to slowly infiltrate the soil and recharge the aquifer, as not to lose the water to the rivers and therefore, the sea. This replenishes the subsoil sources for the summer season, when large volumes are required but precipitation is low and evaporation is high (ANBI Lombardia, 2017). However, these practices, just like traditional flooding practices, have diminished heavily.

Figure 3.23 illusstrates how sattelite imagery has measured the flooded fields over the years. The figures (3.24 & 3.25) on the next page give further impression of how the wetness of the landscape has changed over the past two decades (Gilardi et al., 2023). It gives an idea of the immense effect that changing to a different method for economic reasons has had on the territorial conditions.

Weather stations in the region of Lombardy pointed out that precipitation is the last 3 decades has increased (figure 3.22), contradicting common discourse about climate change precipitation deficits and begging the question how farmers are experiencing water crisis. As explained in paragraph 1.4; precipitation increasingly happens in a shorter timespan with higher intensity, followed by longer periods of drought. The increased amounts of water that fall from the sky fill lakes too quickly and flow unhindered down the plains without deeply infiltrating the soil.

Therefore, the new seasonal dynamics result in less water availability in subsurface and surface sources (which are indicators of drought), exacerbated by decreased use of the watertable-replenishing practices mentioned before (Bove & Ente Nazionale Risi, 2021). Additionally, the widespread transition to dry seeded practice suggests that the ammount of water that is stored underground has decreased. The effects of this transition will be further elaborated upon in the next paragraphs.

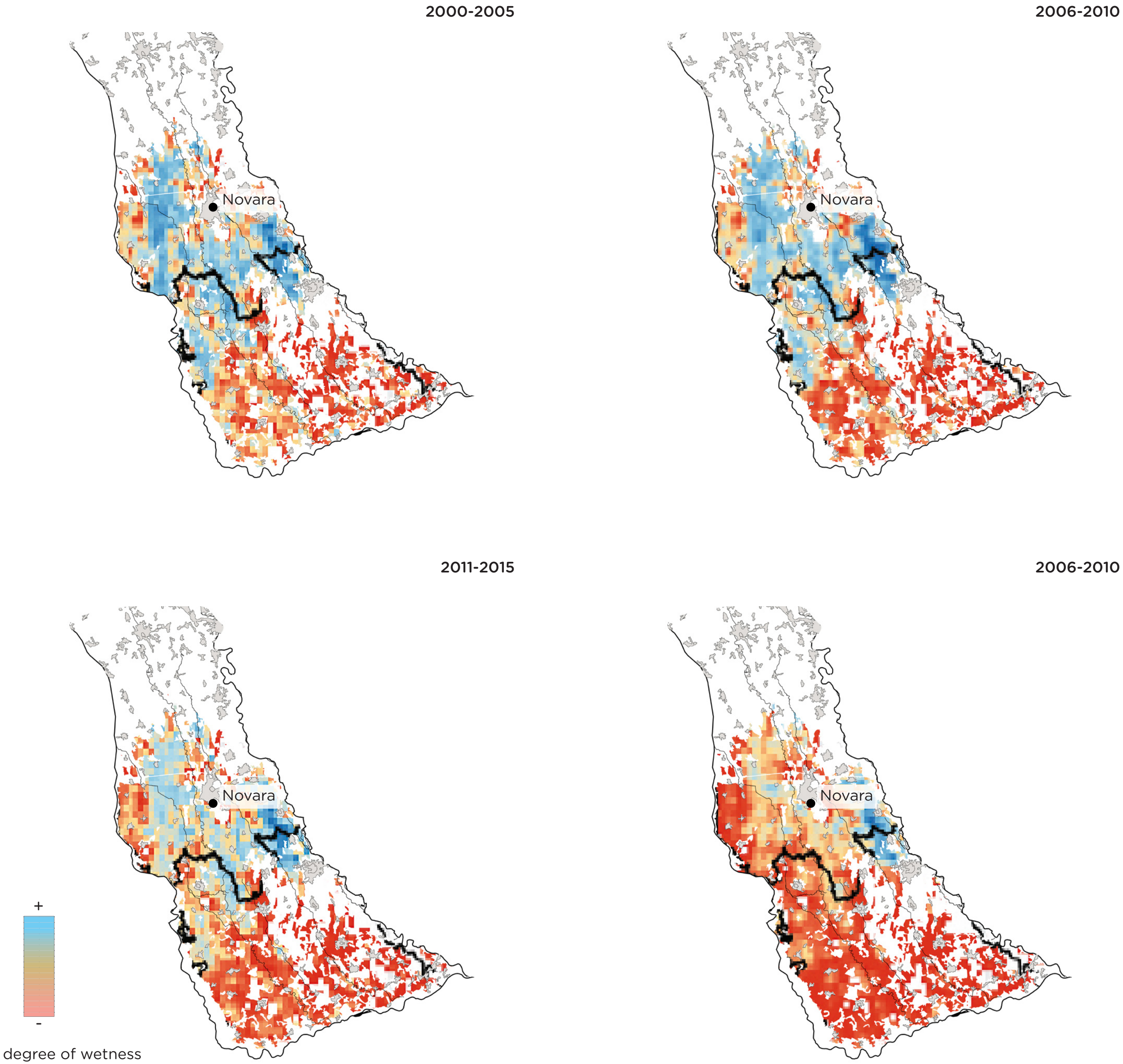


Figure 3.23: Sattelite derived imagery calculating degree of wetness in locations dedicated to rice production, indicating a widespread loss of flooded practice
Ranghetti, L., & Boschetti, M. (2021c).

RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

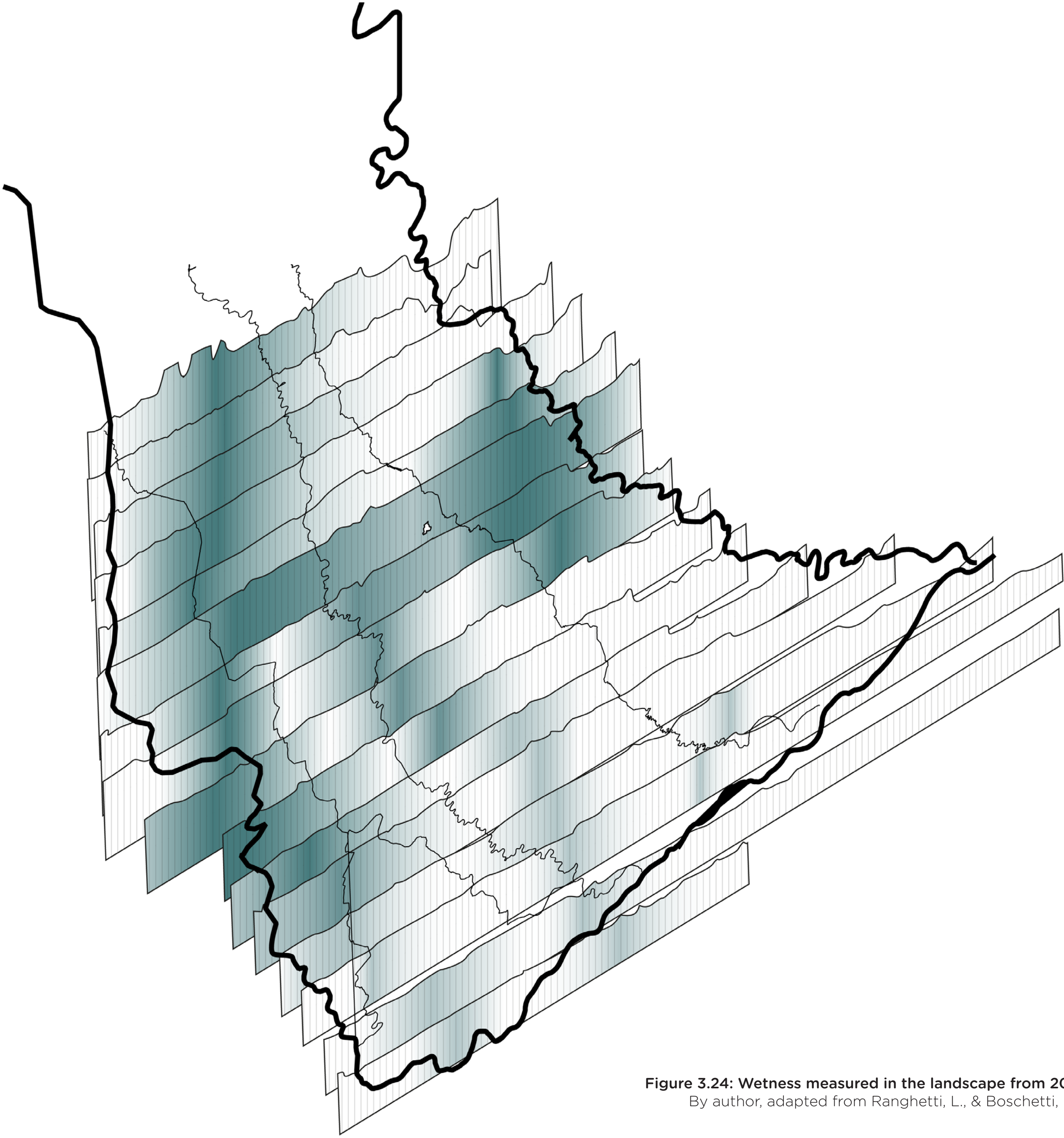


Figure 3.24: Wetness measured in the landscape from 2000-2005.
By author, adapted from Ranghetti, L., & Boschetti, M. (2021c).

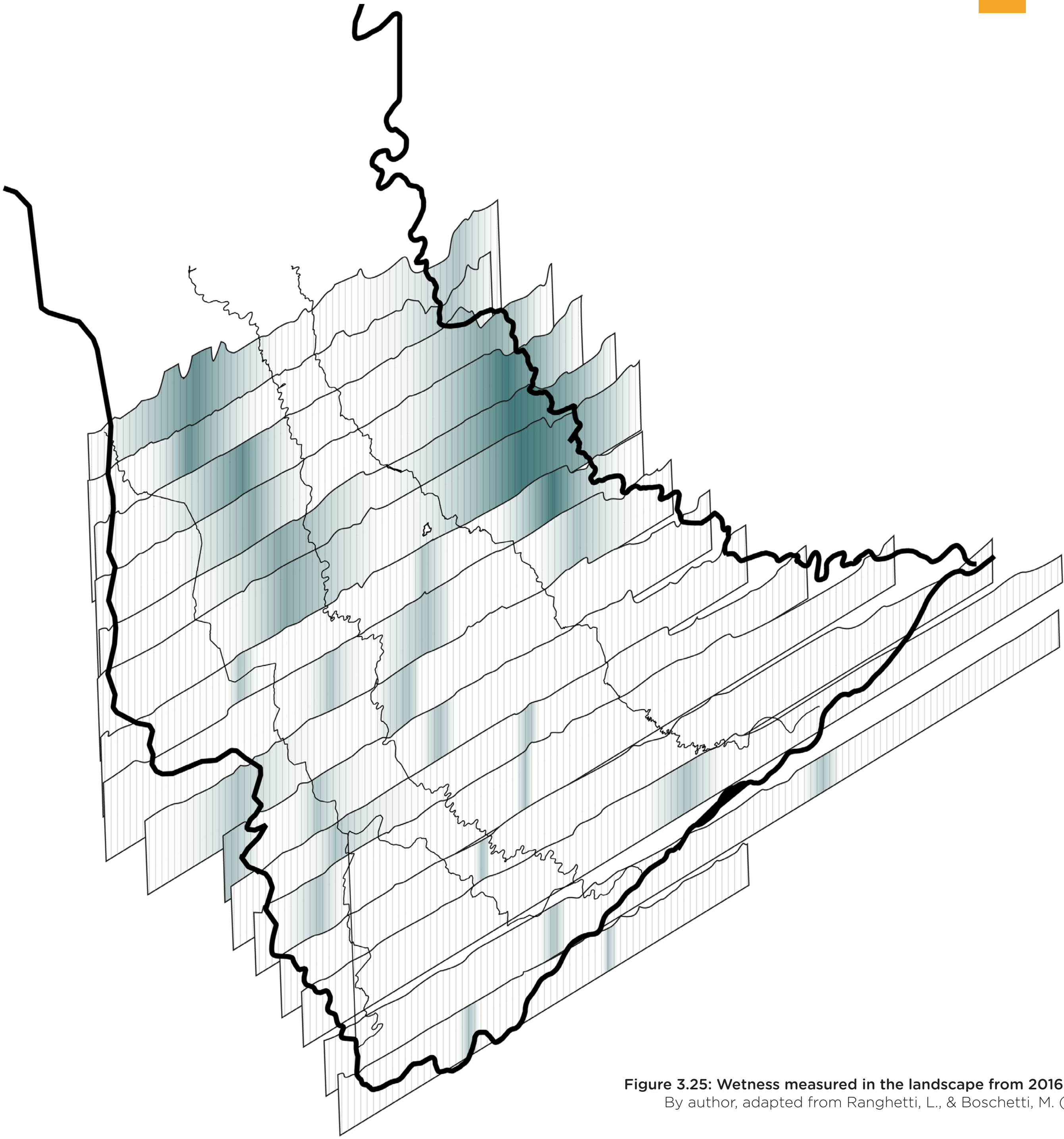


Figure 3.25: Wetness measured in the landscape from 2016-2020.
By author, adapted from Ranghetti, L., & Boschetti, M. (2021c)

3.2.3 Different methods of production

The large-scale transition to the dry seeding of rice has major effects on the state of the landscape. For decades the traditional method of continuous submersion was the only method, establishing traditional landscapes characterized by agro-environmental habitats with unique ecosystem services. The same applies to the water system, that over time has become a delicate but balanced system, working synergistically with environmental features (Ranghetti et al., 2018). To comprehend the effects of the large-scale transition on the workings of this system, this paragraph delves into the details of different production techniques.

Traditionally rice is grown in a submerged state to provide a constant temperature and protect the vulnerable seedlings from the differences between day- and nighttime temperatures. The water in the paddies is about 5-10 cm high, but a portion of the water that is used percolates and/or seeps into the ground (vertical and horizontal flow respectively). Of the water that is used on dense soils with high water tables (clay and loam) 25-50% infiltrates the soil. For coarser soils (sand) with a lower water table, up to 85% of the water infiltrates the soil.

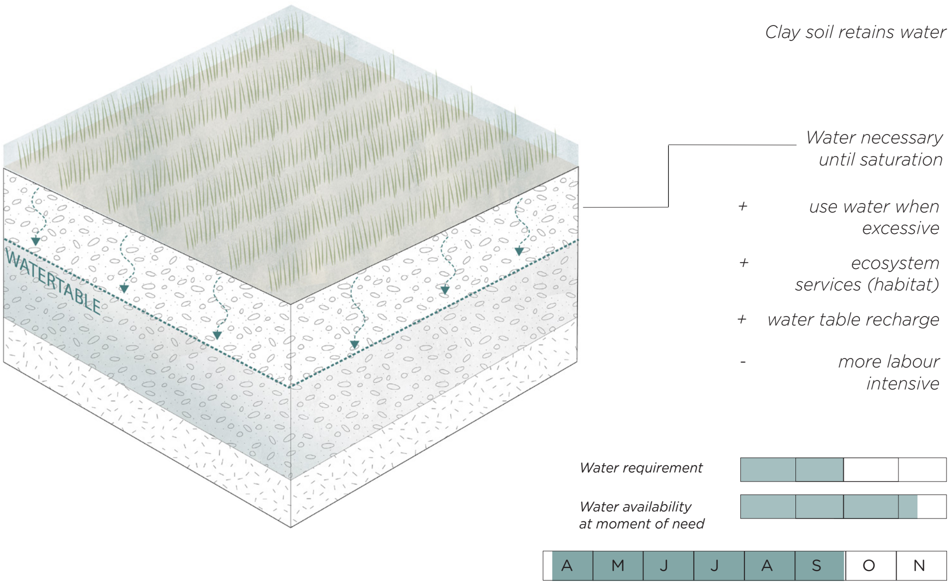
The submersion starts in the midst of April to early May, until September, after which the rice has matured and the harvest starts (Lasagna et al., 2020 & Balestrini et al., 2021, as cited in Ranghetti et al., 2021). The water that infiltrates the soil recharges both the aquifer as the water table, which is important as a satiated soil is necessary to allow for the fields to remain flooded. Next to that, as in spring the canals are filled with meltwater from the Alps, water is considered abundant and can be used opportunistically to infiltrate.

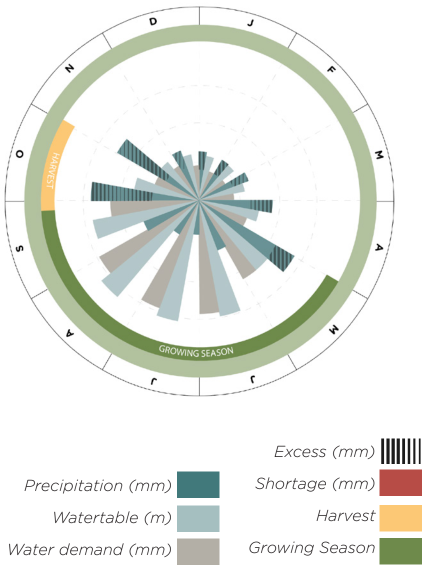
As the name suggests, in dry-seeding, the seeds are sown while the fields are not yet submersed. Instead of starting in April, fields can be flooded from June onward, so since the moment of submersion is postponed, dry seeding rice (method) demands less water in the earlier stages saving about 20% of water. In the past, this was limited as the low temperatures of the night would affect the vulnerable seedlings. However, due to climate change and the resulting increase in temperature (especially in spring), the circumstances now allow for the application of dry seeding earlier in the year and higher in the basin (Ente Nazionale Risi, 2015 & Zampieri et al., 2019, as cited In Ranghetti et al., 2021).

Dry seeding is often preferred since it is less complicated, it saves manpower for the irrigation of fields, it makes it easier to combat ‘red rice’ (rice’s feared weeds), and it requires less expensive machinery since the fields can be treaded in dry circumstances. Although decreased water requirements might appear beneficial for sustainable water use, the demand for water increases during the summer when there is less water in the canals and other agricultural productions also have heightened water needs (De Maria et al., 2016). Figure 3.28 & 3.29 show how the methods conflict in their water use.

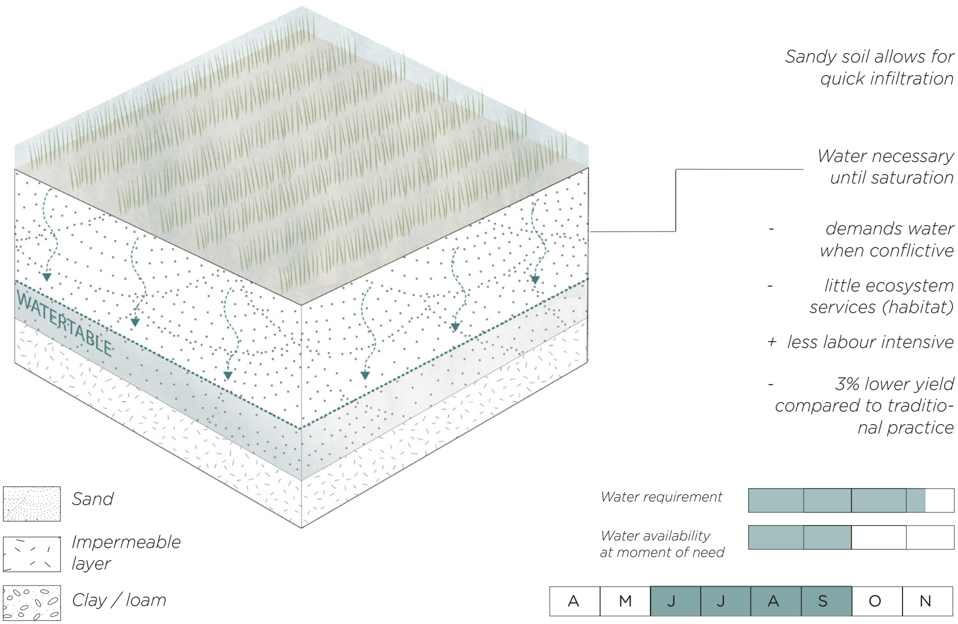
Another reason for its popularity is that dry-seeded rice can be applied on looser soils like sand, since sowing starts later in the year. This means that the water table is already higher due to flooding practice elsewhere. This is also suggested by figure 3.23 as rice production occurs in places where even between 2000 and 2005 little to no flooding practices were measured.

Traditional Practice





Dry Seeding Practice



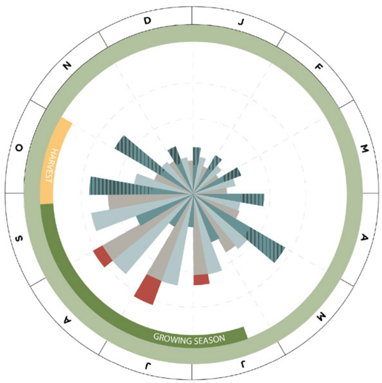


Figure 3.26 & 3.27: Effects of the different methods.

Figure 3.28 & 3.29: The water dynamics of traditional flooded practice and dry seeding practice respectively.

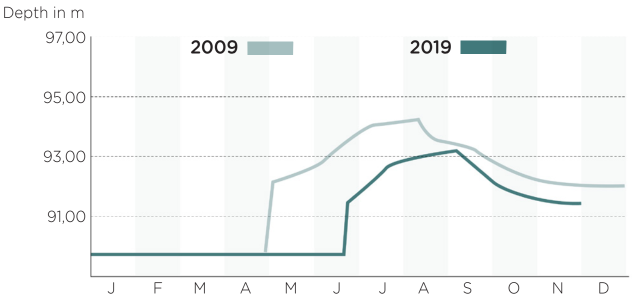


Figure 3.30 Measurements of the watertable level between 2009 and 2019, in an area that has near completely transitioned to dry-seeding practice (Sartirana, Pavia).
By author, adapted from Est Sesia., in Bove en Ente Nazionele Risi (2021).

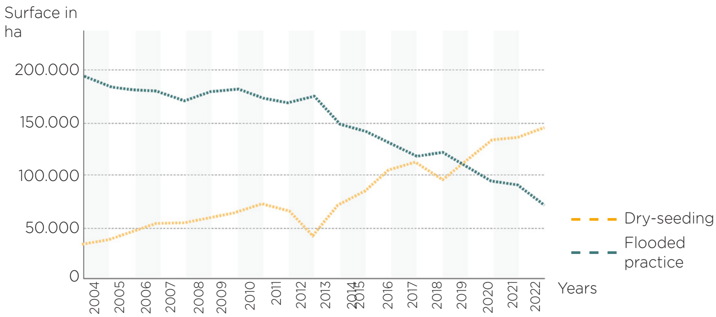


Figure 3.31: A sharp increase in dry-seeding applicance is seen over the years, eventually exceeding flooded practice in 2018.
By author, adapted from Romani & Ente Nazionele Risi (2023).

3.2.4 Territorial effects of different methods

Although the decreased water use might appear beneficial in terms of sustainable water use, the water demand increases during the summer when there is less water in the canals and other agricultural productions have an increased need for water as well (De Maria et al., 2016). A decrease in irrigation demands could potentially lead to suffering rates of aquifer recharge, intensified by trends of water scarcity and drought (Monaco et al., 2016).

Research by (Baker et al., 2022) revealed that between 81% and 91% of the surficial aquifer recharge in the summer season can be traced back to flooding practices of rice production, additional to water that percolates in the various canals for irrigation. Due to its continuous submersion in the irrigation season, these fields are able to elevate the water table approximately four to five meters, as well as diluting the high nitrate concentrations in the groundwater. (Rotiroti et al., 2019, Lasagna et al., 2020).

Figure 3.32 & 3.33 illustrate how the methods operate in the field if applied on a large scale, which helps to understand the exacerbation of droughts mentioned earlier. In flooded circumstances, water is used when it is abundant to submerse the fields, satiating the soil, recharging both aquifer and watertable and seeping through the orography to lower in the basin, where it comes up through the soil in natural springs. In summer, when the water demand by rice decreases, the demand for other practices can be met as the water table is still high.

In dry seeding however, flooding is postponed, making water that is then "abundant" flow through the rivers to the Po and losing it to the Adriatic sea. When the flooding starts in June, the water table is lower since it has not been recharged by flooding practice and less water is available overall while the demands are higher. Finally, the situation further intensifies as higher rates of water are necessary to satiate the soil and be able to flood the fields.

This means that the result of applying dry seeding on a large scale is depletion of surface and subsurface water sources while leading to conflicting demands over these sources. Additionally, as mentioned in paragraph 3.2.2, techniques that raise the general water table are not adhered to anymore, while the more water recharging the aquifer in winter would mean the more water is available during summer.

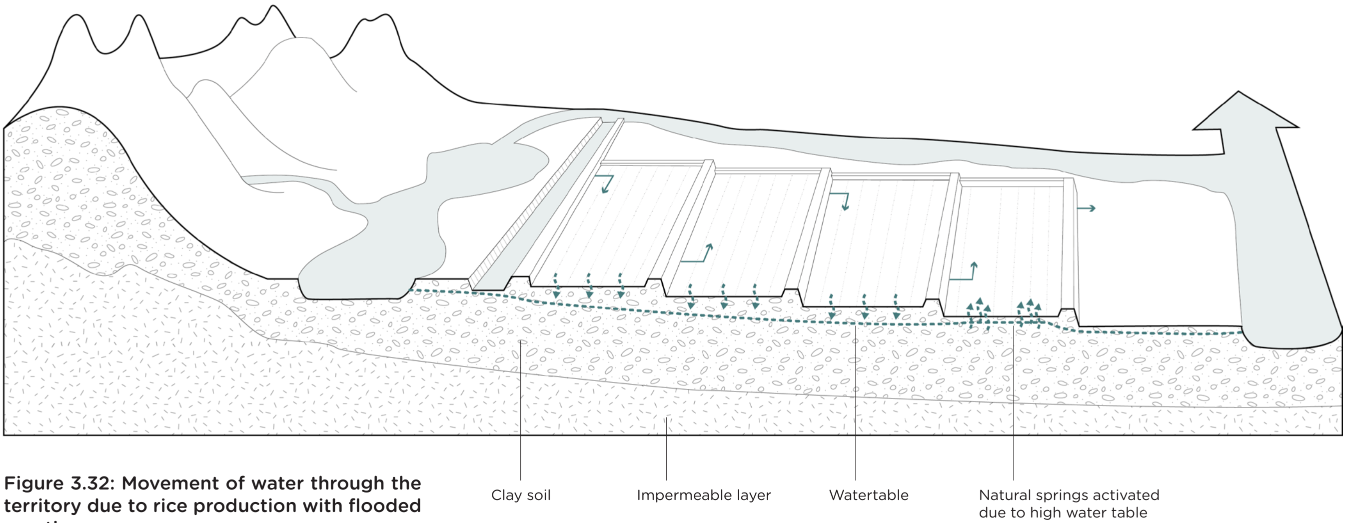


Figure 3.32: Movement of water through the territory due to rice production with flooded practice.

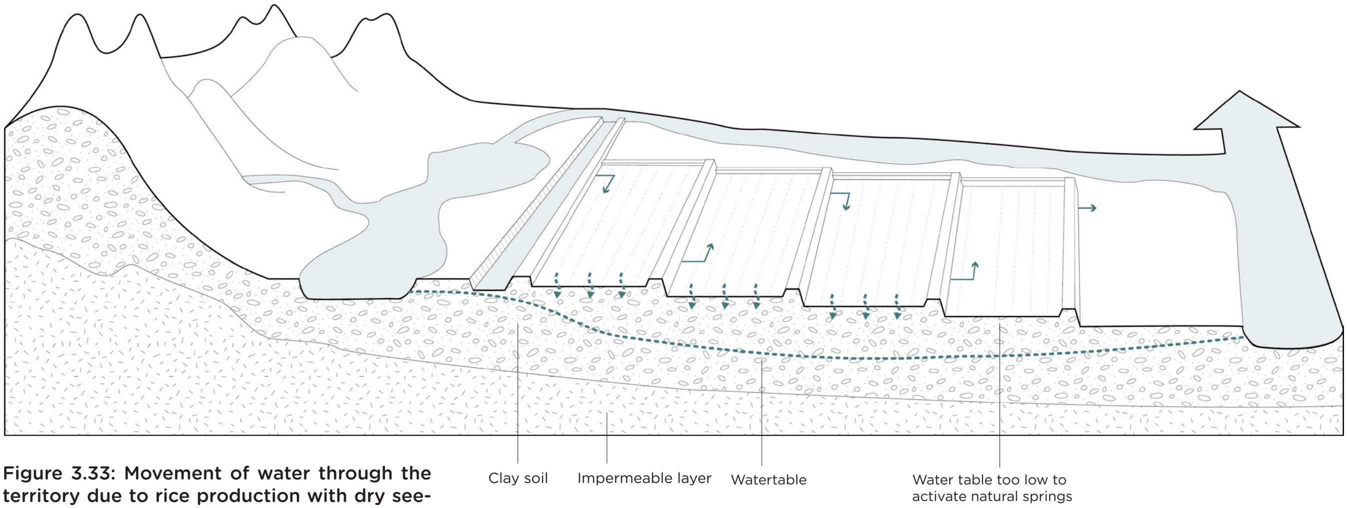


Figure 3.33: Movement of water through the territory due to rice production with dry seeding practice.

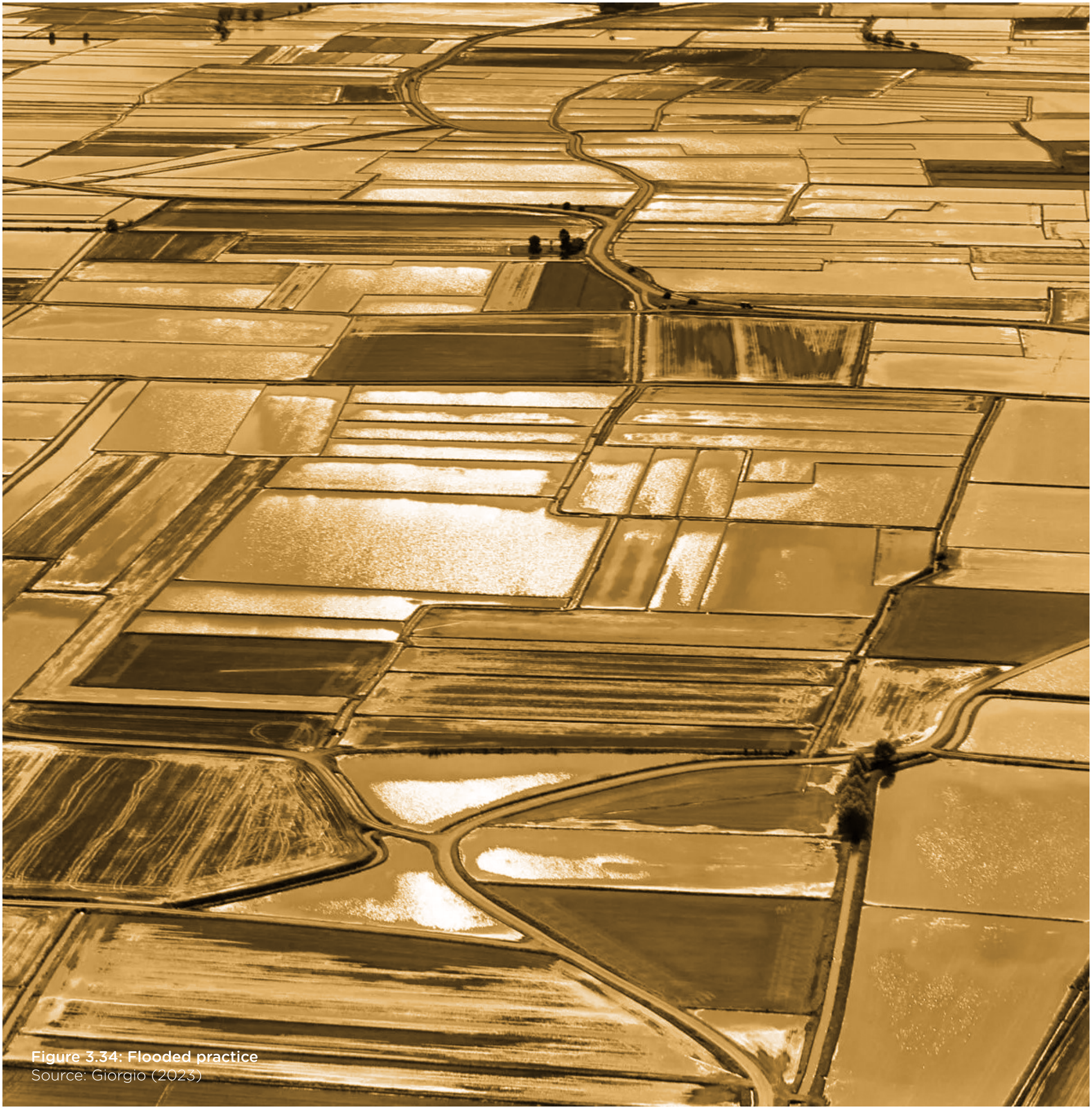


Figure 3.34: Flooded practice
Source: Giorgio (2023)

Figure 3.35: Dry-seeded practice
Source: Risoitaliano (2023)

Ploughing and levelling in winter *Sowing and flooding in spring* *Growing in summer* *Maturing and harvest in autumn*

Figure 3.36: Seasonal values in the landscape.
Source: Rolando & Scandiffio, 2021.

3.2.5 Landscape values

The fields are carefully levelled according to the orography, in such a way that every drop of water is used as many times as possible, flowing from one field to the next before it infiltrates the soil. The rice production landscape is lined by the intricate system of canals, ditches and roads in between. The latter is used for mainly agricultural purposes. Additionally, their careful maintenance makes them perfectly suitable for tourism in the form of cycle and pedestrian routes, from which the seasonally varying landscapes can be experienced (Rolando & Scandiffio, 2021).

The greater and smaller landscape components, composed of infrastructural elements and farmers' individual practices, form the structure of the territory in which socio-cultural and economical values are captured. The presence of trees, traditionally placed along the water channels on both sides, or lining the edges of fields, help to protect the structural integrity of the soil and shelter the fields from strong winds. The individual farms are linked to the network of roads and rise up like islands in the checkered sea when the fields are flooded (Papotti & Brusa, 2022). These elements compose a widely appreciated cultural landscape that changes throughout the seasons (figure 3.26).

In winter the soils are often nearly bare and the fields are levelled and ploughed, after which, in spring when the temperatures are increasing, the fields are flooded for sowing and they attain their characteristic allure. This remains until the rice has matured, after which they turn from green to yellow in autumn and are ready for harvest (Rolando, A., & Scandiffio, A., 2021).

Notably, the traditional method of rice production offers quite the potential for ecological habitats. Since 80-90% of all natural wetlands in Mediterranean Europe have been lost to humans, flooded rice fields provided an important alternative for aquatic wildlife. Migratory- and waterbirds as well are frequent guests in the flooded chambers, foraging and resting on their journey of migration (Ranghetti et al, 2018). Over the years however, the chambers have increased in size while the characteristic lining elements like hedgerows and trees have disappeared. In doing so, rice production has lost much of the ecological habitat that it had to offer (figure 3.37).

According to Michele Bove (2021) of department of Agriculture and Rural development of the Ticino park, there is a great risk of the characterizing water landscapes to turn into a landscape of dust (figure 3.34 and 3.35). Attention should be devoted to recovering and nourishing of the flora and fauna that the traditional rice landscape harbored, which would in the end favor rice production as well. Maintaining an environment suited to the flora and fauna typical of the rice-growing landscape would also favour the return of natural mosquito predators, which disappeared precisely following the introduction of dry-seeded practice.

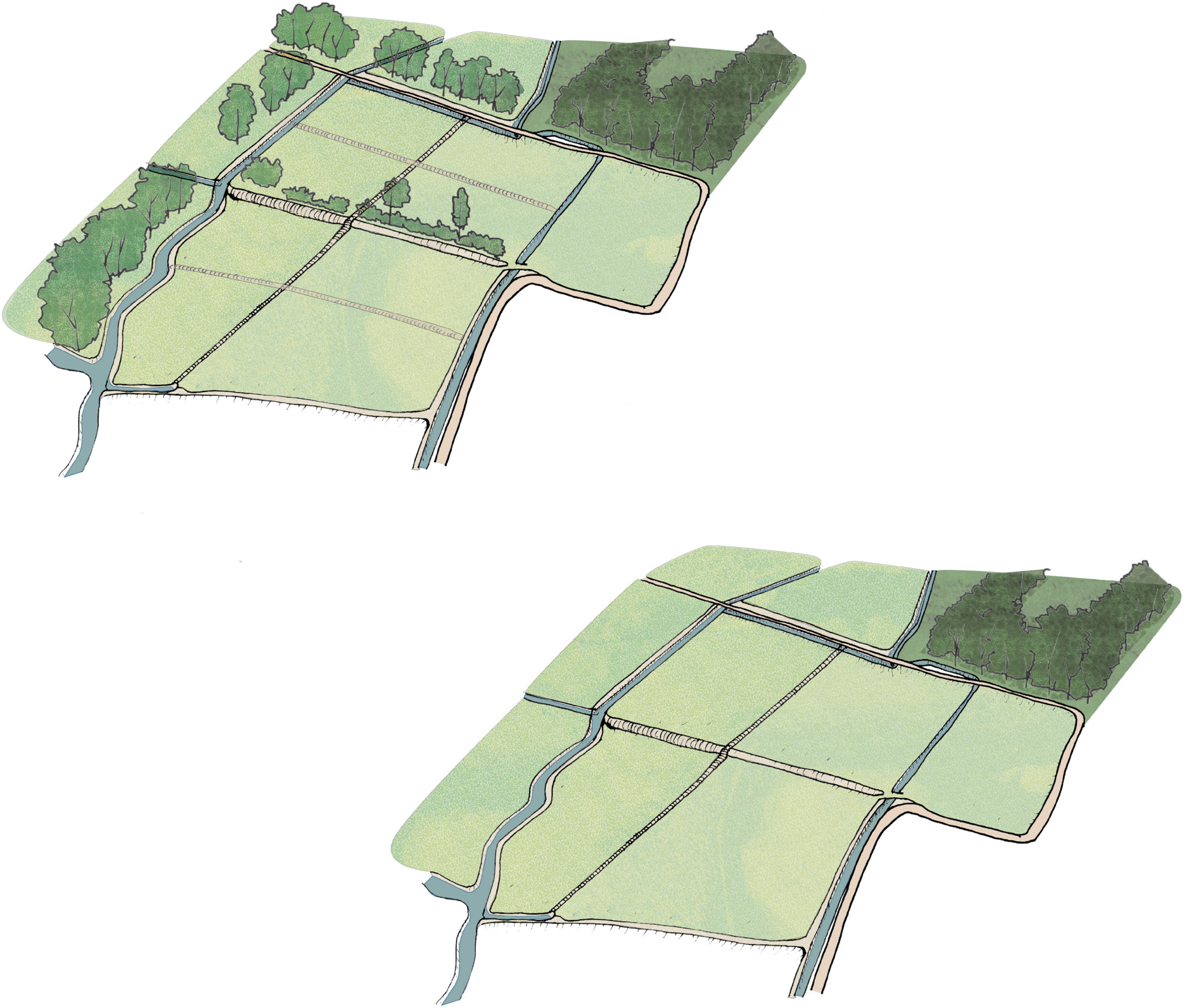


Figure 3.37: Disappearance of landscape elements over the years.

Research synthesis

“

In favor of **economic revenue**, changing the methods of production and **disappearance** of their characteristic **landscape elements** have **disrupted** the **balance** that is fundamental for achieving the right **agronomic conditions** and providing **ecosystem services** for both rice production and nature.
This results in **decreased water availabililty** and **loss of habitat**,
further intensified by climate change.

“

3.3 Conclusion

First, the two research questions are conclusively answered below. These provide the basis for answering the research questions, leading to the principles that the design has to focus on.

- How does rice production interact with and alter natural processes and landscapes?

- How does climate change impact the hydrological system of the region and the different processes related to rice production?

- Applying dry seeding on a large scale, disrupts the established water balance, resulting in depletion of surface and subsurface water sources while leading to conflicting demands over these sources.
- Techniques to use water when it abundant and store it underground are not adhered to anymore, contributing to additional water loss, further aggravated by climate change.
- In- and extensification of rice production has resulted in important habitat and ecology being lost, impairing the landscapes natural resilience.

The problem stated in paragraph 1.2 and incorporated in the problem statement, elaborating on how the current exploitative mindset of viewing nature, and with that water, affects the biospheres resilience, can also be seen in problems that rice production encounters in the region. This further stresses the importance of this work in restoring the connection between humans and their environment. So to answer the main research question:

How to provide water security for rice production fitting to evolving water dynamics while improving the connection between humans and nature in the paradigm case of the Ticino, Sesia and Po river?

To provide water security for rice production that fits to the precipitation dynamics dictated by climate change, a balanced water cycle is to be ascertained. To re-establish this, water must be retained in the landscape for as long as possible, preventing it from being lost to the rivers and, ultimately, the sea. In the context of rice production, this means counteracting the widespread transition to dry-seeded practices by reverting to traditional flooded practices. Reintroducing lost concepts or creating new ones that utilize water when it is abundant and store it underground can help retain water in the landscape.

Furthermore, to compensate for the habitat and ecology lost due to the intensification and extensification of rice production, and to restore the landscape’s natural resilience, agriculture must provide habitat.

Finally, to further improve the connection between humans and nature, people can be made more aware of their views of nature or encouraged to engage with nature. Also, design could strategically tap into people’s feelings towards certain characteristics of natural area’s.

Widespread dry seeding practice leads to conflict over and depletion of surface and subsurface water sources.

Techniques to use water opportunistically are not adhered to anymore, contributing to additional water loss, further aggravated by climate change.

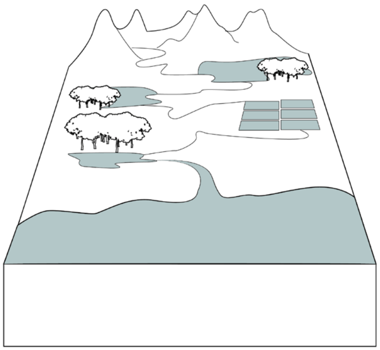
In- and extensification of rice production has resulted in loss of habitat and ecology, impairing the natural resilience of the landscape.

Conclusion

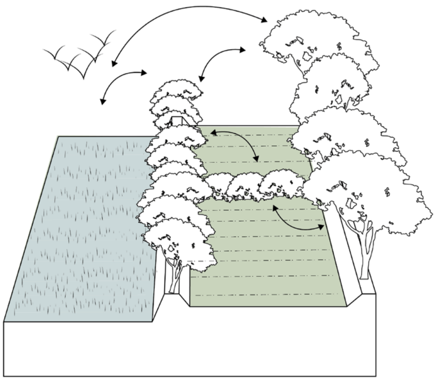
"

To obtain water security and improve the connection between humans and nature, a **balanced water cycle** needs to be re-established. This can be done by **retaining water in the landscape** as long as possible, while **providing habitat** by agriculture.

"



Retain water in the landscape as long as possible



Provide habitat by agriculture

Figure 3.38: Design principles.

Figure 3.39: Section of the Cavour canal.
Source: Riso Rizzotti (2022)

4 DESIGN STRATEGY

The following chapter translates the design goals into a strategy on the subregional scale. The chapter begins with an exploration of strategies aimed at reinforcing habitat provision in agricultural landscapes and enhancing water security. These strategies focus on invigorating the current landscape to better accommodate changing water dynamics. The strategies are transformed into design interventions that are applied to the specific urban-rural context of Novara. Here, the design interventions are worked out in detail, showcasing their ability to reinforce the present situation and opportunistically address environmental challenges.

4.1 Design questions

The research has concluded the main conflicts and translated them into the two goals the design will focus on;
- retaining water in the landscape as long as possible
- providing habitat by agriculture

To this end, a strategic vision has been developed on the meso scale, forming the foundation for design interventions. These interventions are the buildings blocks of the stategy. To make these interventions explicit, they will be implemented in specific test beds, demonstrating their application in context. Paragraph 4.2 will further explain why the vicinity of Novara has been chosen.

How can design reinforce habitat provision in agriculture, enhance water security and improve the human-nature relationship in the urban rural context of Novara?

SUBQUESTIONS

What are the specific socio-economic and environmental challenges faced by the landscape Novara?

What agricultural practices are most effective in promoting biodiversity and can be integrated with rice production in the specific context of Novara?

Which interventions can retain water in the landscape and simultaneously strengthen habitat provision?

How can urban planning incorporate elements that promote a harmonious human-nature relationship?

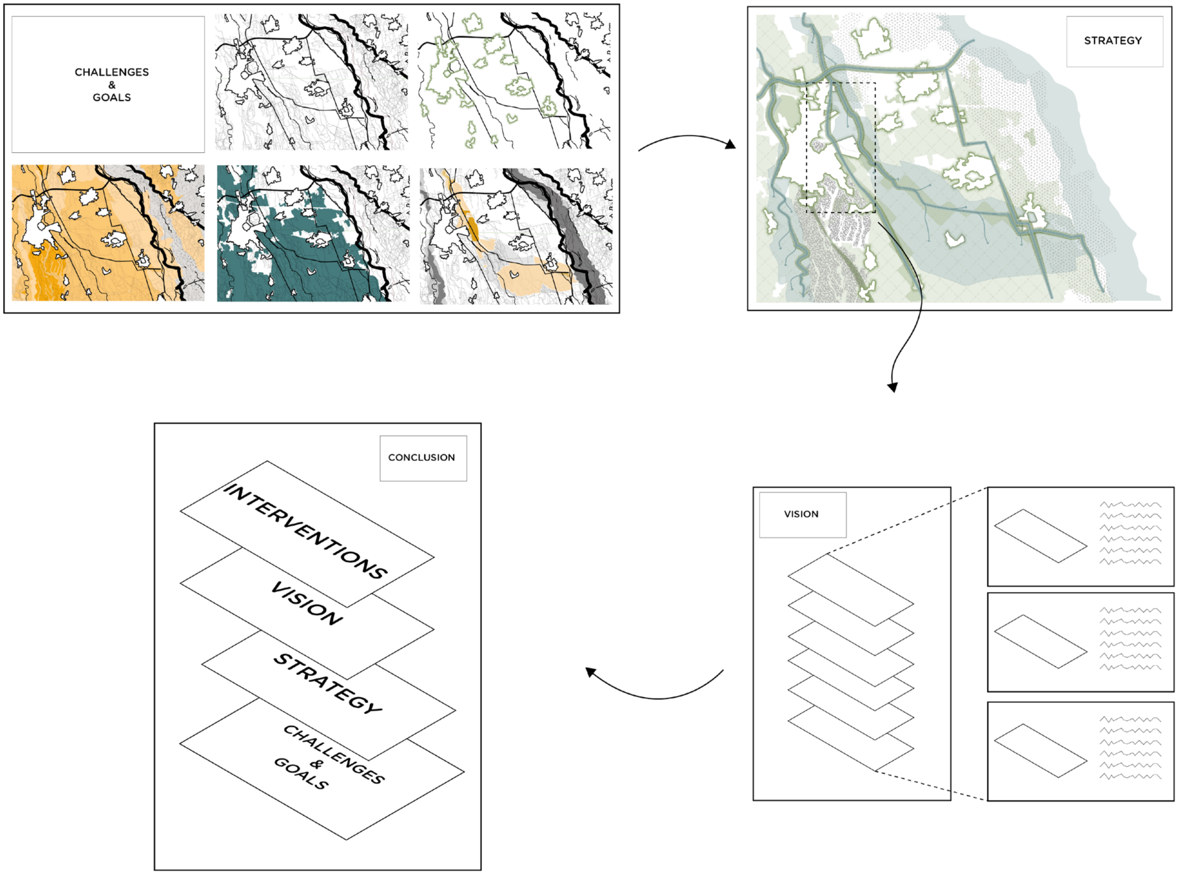


Figure 4.1: Design strategy process.

4.2 Meso scale
current situation

The city of Novara and its vicinity have been chosen for their flood hazard, diversity of soiltypes, drought anomalies and promixity to the Ticino park, providing a multiplicity in potential testing beds. Transitioning from analysis at the regional scale to the meso scale, the design latches onto five themes: soil characteristics, built environment, hydrological system, floodplains, and rice production.
For each of the five themes, the goals are stated in figure 4.3.1-4.3.5. What follows is a brief description of how these themes are approached in the strategy.

The water structure focuses on retaining water, reducing evaporation, and using water to support habitats.

To retain water longer in sandy soil, the natural drainage capacity should be postponed. On the contrary, heavy clay areas might require enhanced drainage. Their qualities can be utilised opportunistically.

Floodplains can be utilized for water storage during inundation and multifunctional land use, providing water for landuse types that require more than others.

The structure of rice production and its methods are transformed to reinforce habitat.

Currrently, city borders are harsh and direct, therefor a buffer zone will facilitate a new transition and prevent polluted runoff water from entering the waterstructure.

To inspire a different attitude toward nature, challenges are approached opportunistically through multifunctional interventions, demonstrating that nature can provide the flexibility needed to address the effects of climate change.

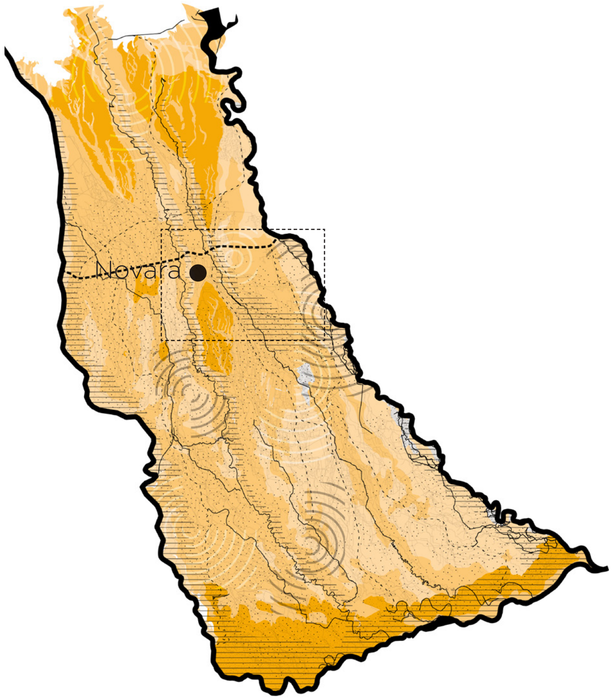
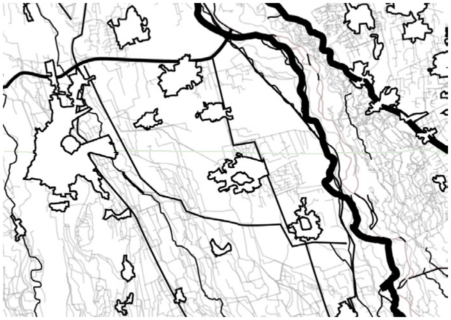
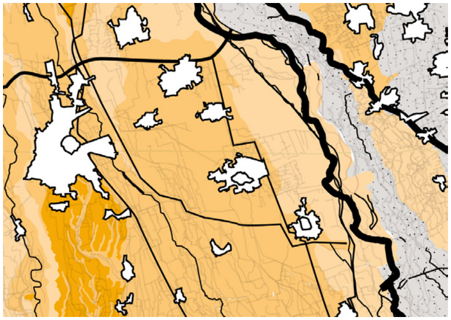


Figure 4.2: Location for the design strategy.



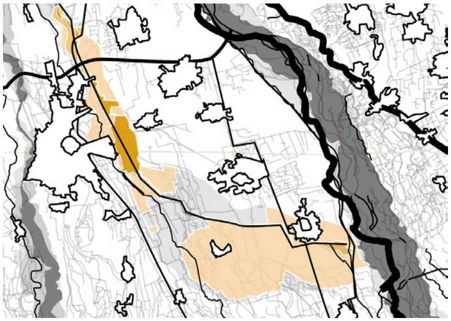
1 Waterstructure

- reduce evaporation
- use water for habitat



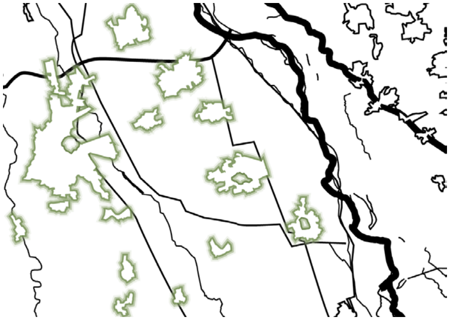
2 Soil

- postpone or utilise natural drainage
- increase drainage capacity



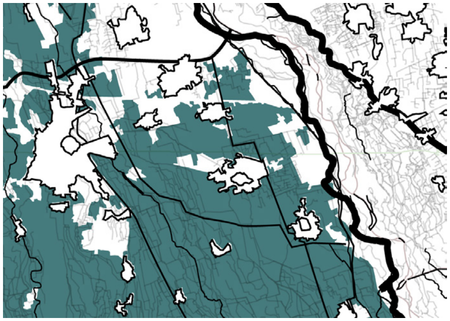
3 Floodplain

- store inundation water



4 City borders

- provide buffer zone
- reduce polluted runoff



5 Rice

- use traditional flooding
- increase ecological habitat

Figure 4.3.1-4.3.5: Analysis of the current situation and the goals that apply to that theme.
1 & 3: By author, from data published by Autorità di Bacino Distrettuale del Fiume Po, 2019)
2: By author, from data published by Regione Lombardia & ERSAF (2024) and Geoportale Piemonte (2024)
4 & 5: By author, from data published by Copernicus & Land Monitoring Service, 2023

4.3 Design strategy

This translates into a strategy where the canals are transformed to ecological corridors by providing their structure with ecologically friendly banks and connecting their course with adjacent wetlands and alluvial forests.

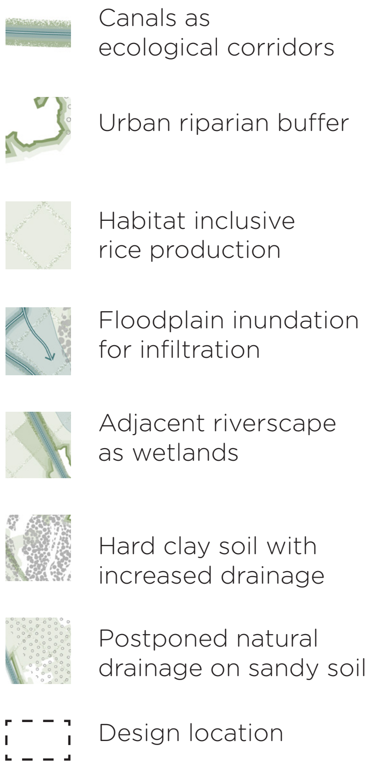
Rice production will adhere to a new form of production: organic rice offers various types and amounts of vegetation and becomes the connecting fiber that weaves the ecological corridors together.

The floodplains are used to store and infiltrate water by natural landuses that can retain water such as alluvial forests, wetlands and water meadows.

Urban riparian buffers following the natural relief provide a new transition between urban and agricultural land, while preventing polluting runoff water to enter the waterstructure.

On sandy soil, interventions through design by nature should aim at postponing the natural drainage to retain water longer, or be used tactically to infiltrate water in times of excess. This is however not further worked out in this the scope of this design strategy, and would require an additional testing bed & corresponding design.

All of the interventions are chosen for their ability to be applied onto existing structure or their fittingness to territorial properties to enhance the cultural landscape. In the design phase on the next pages, the interventions are applied to their specific context, for which the urban-rural setting of Novara city has been chosen.



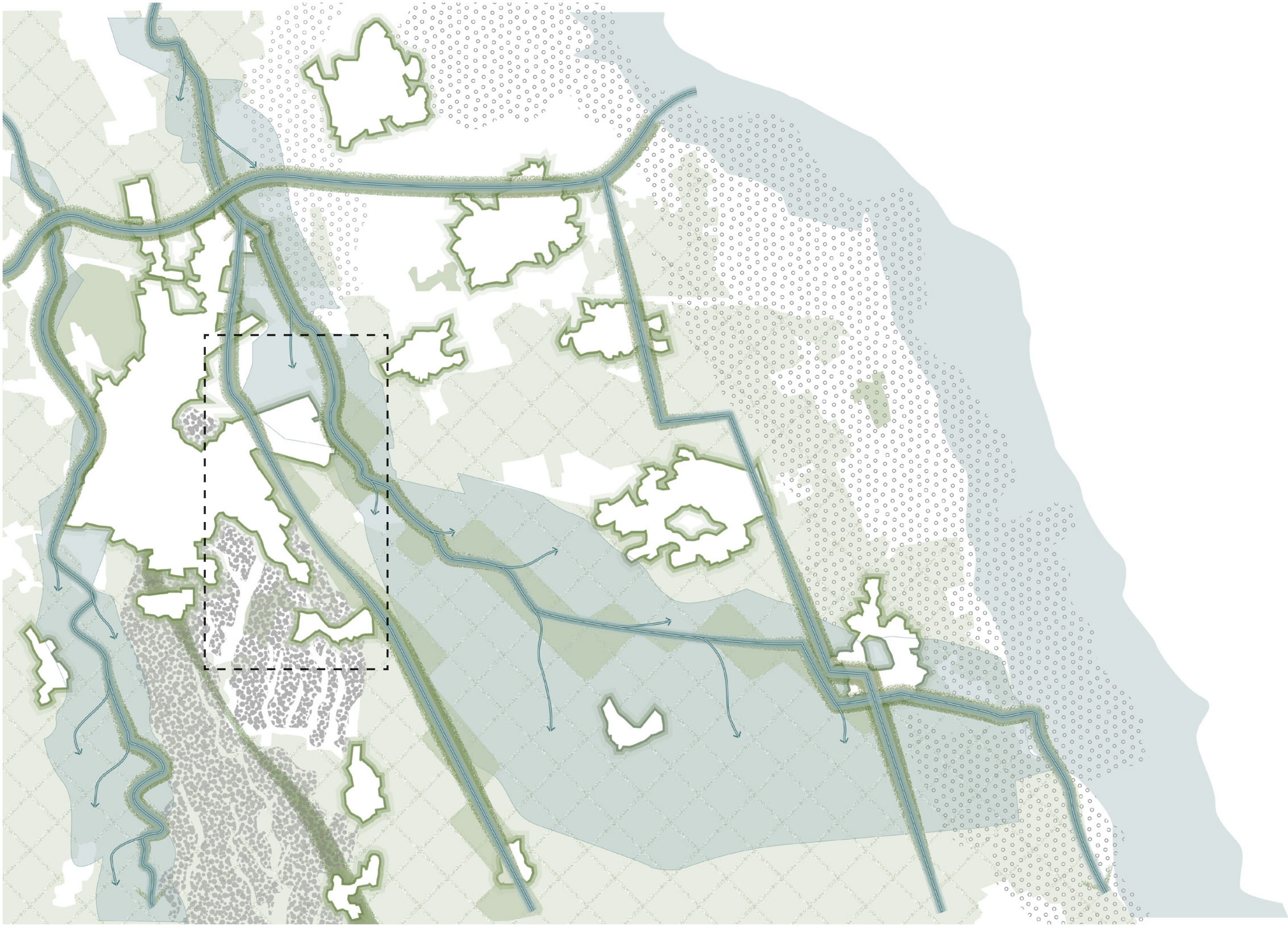


Figure 4.3: Subregional design strategy.

4.4 Urban rural vision:
Novara

The urban-rural vision provides the city with a new transition to the rural hinterlands by a riparian buffer that coincides with embankment transformation and a water filtration park (see figure 4.2, element 2 & 3)
The floodplain of the river is transformed into a tidal park, which can be flooded in times of heavy precipitation while still functioning as a park for inhabitants that integrates rice production (5).
The industrial plain that covers a large portion of the area leads to polluted runoff water. The water is captured in natural and artificial canals and purified by a combination of wetland parks (1).
The rice production landscape adheres to a more sustainable and nature inclusive method, organic rice (6). It's structure allows for enhanced habitat and connections between the different landcovers. Routes throughout the landscape for cyclist and hikers are created and reinforced to stimulate engagement with natural areas and the design interventions (4).

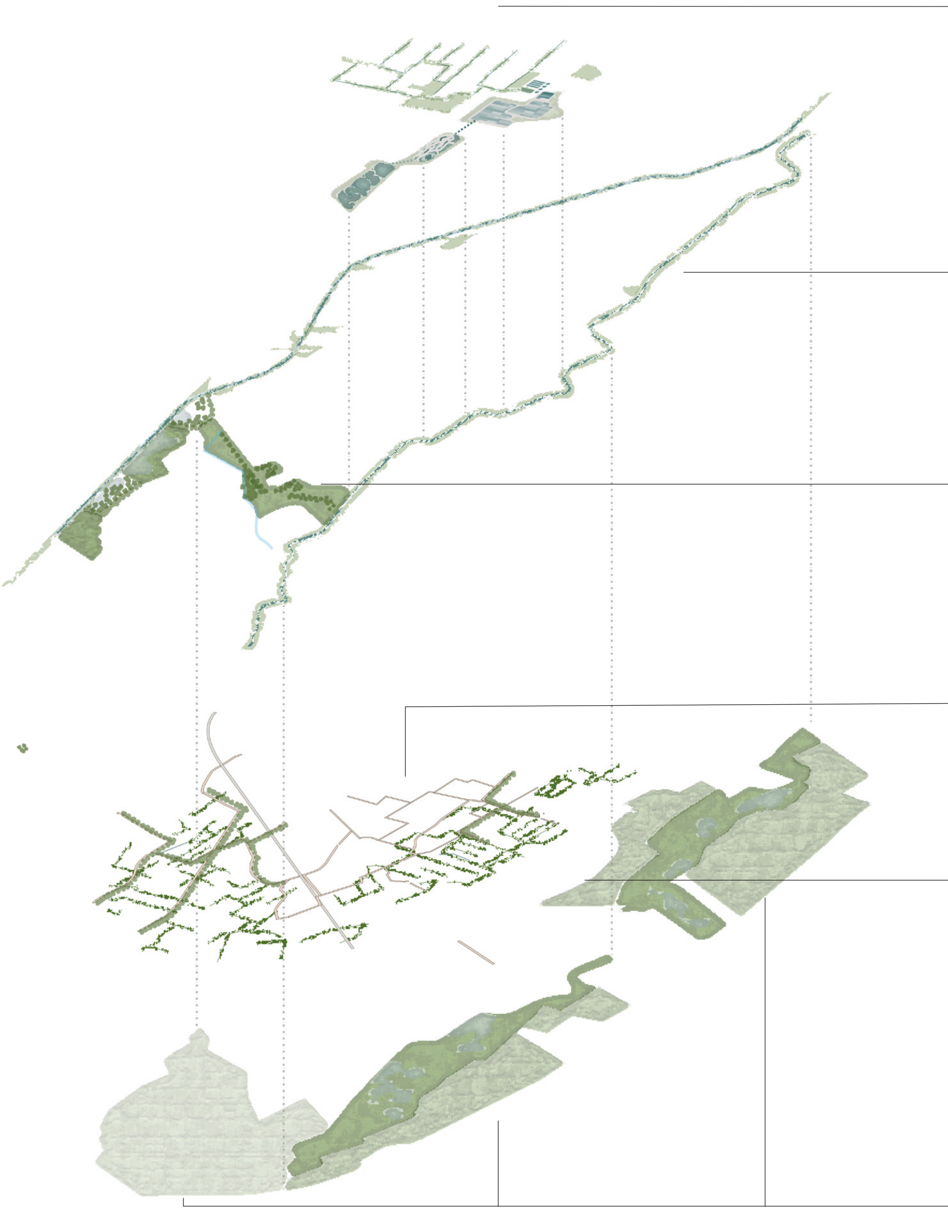


Figure 4.2: Isometric view of the design interventions.

Source: Hong Kong Wetland Park | Hong Kong Tourism Board, (z.d.)

Source: Van Rijnland (2021)

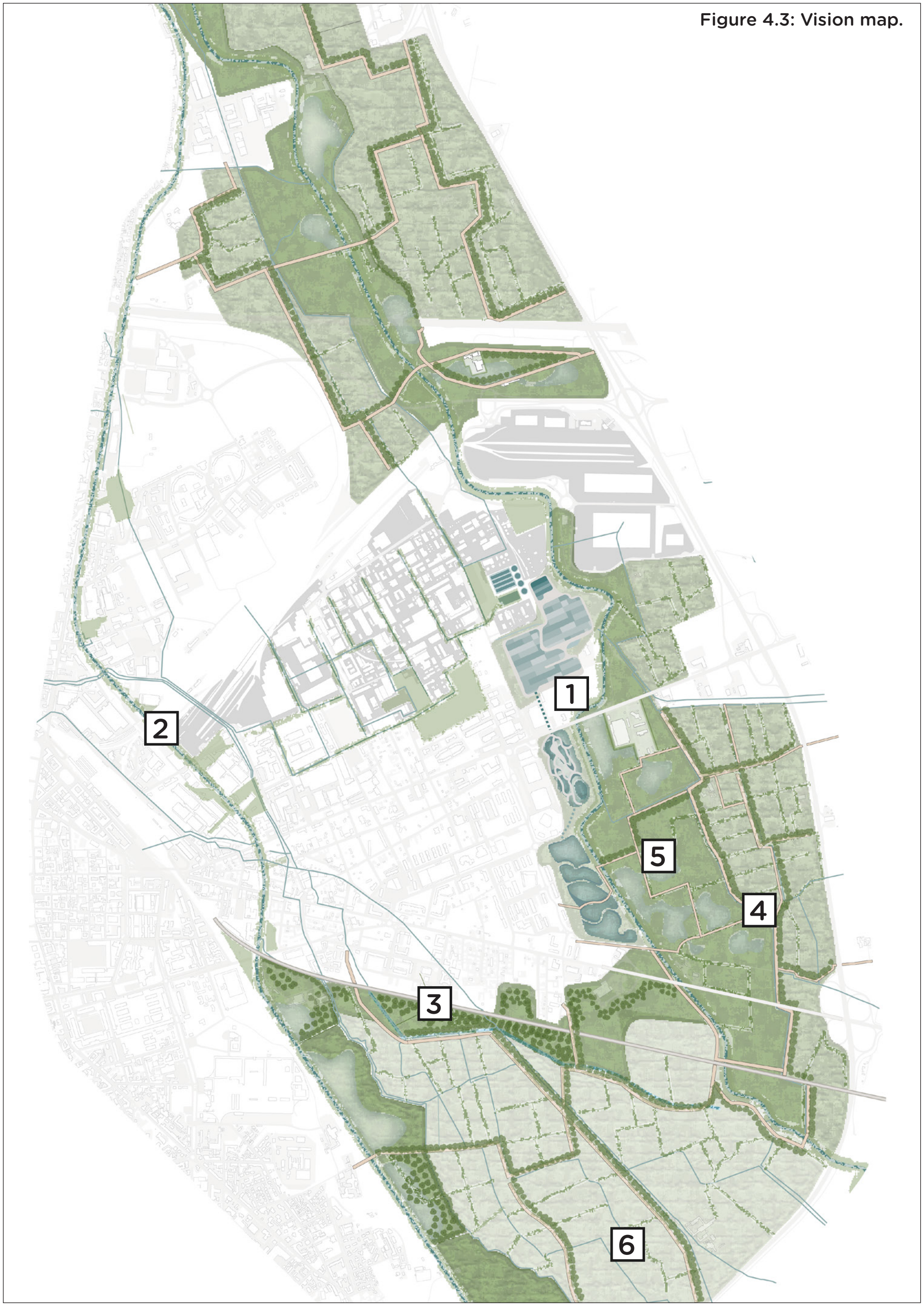
Source: M Aten (z.d.)

Source: Benedict (2019)

Source: NvRP, (2024)

Source: Una Garlanda farm, Rovasenda (Riso Italiano, 2021)

Figure 4.3: Vision map.



4.5 Interventions
4.5.1 Organic rice

To transform rice production in its current state to a type that provides more habitat for ecology and retains water in the landscape longer, the method of organic rice has been chosen. This is a method that grows rice without the use of synthetic fertilisers and pesticides and makes conscious use of water and soil. It integrates diverse plant species into the structure of its plains, reinforcing its potential in providing shelter and forage for various species. These, in turn, can deliver natural pest management as an ecosystem service. Overall, organic rice offers increased environmental performance and potentially mitigates the impact of rice production on natural resources while allowing the soil to heal and clean itself through ecological processes.

The method, called "green mulching", discovered after years of research and attempts by Fulvio Stocchi (Ghiardo, 2023), works as follows: before the rice is sown, a so-called cover crop is introduced in the field, such as Italian ryegrass (Lolium multiflorum Lam). The rice is sown on top of the cover crop which is then flattened by shredding or roller-crimping, after which water is introduced. This leads to fermentation of the cover crop, as well as negatively impacting weed germination. The increased levels of biodiversity that this method delivers, provide essential ecological services that can provide agroecosystems the power to improve their own soil fertility, protection and productivity (Altieri, 1999, p. 29, as cited in Ghiardo, 2023, p. 123).

Figure 4.3: Rice fields.

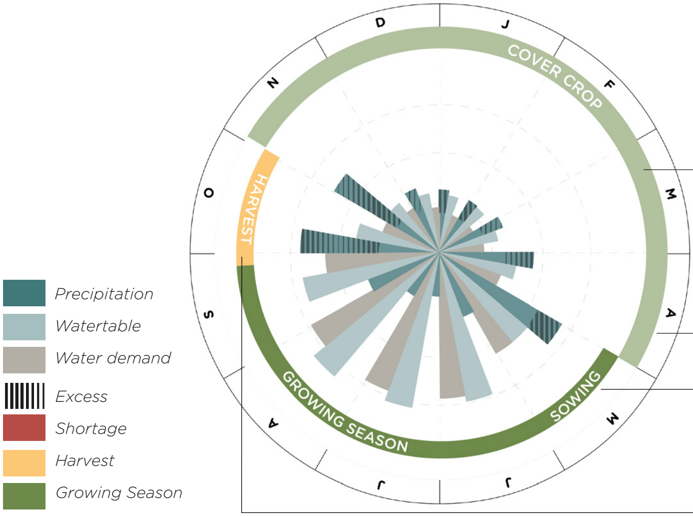


Figure 4.4: Dynamics of organic rice production.

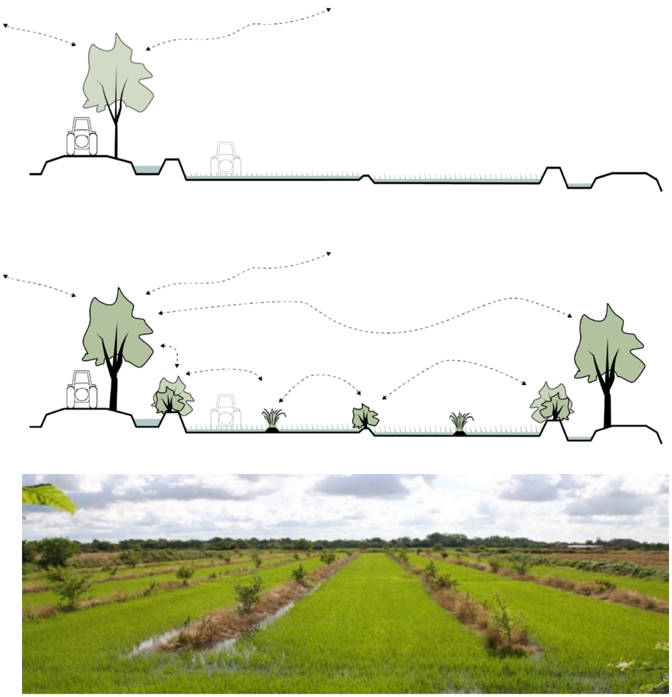


Figure 4.5: Increased amounts of vegetation integrated within rice production.
Source: Riso Italiano, 2018b.

Green mulching

Flattening

Sowing

Growing & harvest

Figure 4.6: Phases of organic rice production.

The method of organic rice, although research is necessary for its improvement, is an example of a method that brings the production of food and its environmental effects in close connection to health (Ghiardo, 2023). Addionally, the practice demands careful attention to the specific ecological properties of the location it is applied to. In this way, it stimulates a nourishing relationship since farmers are encouraged to reconnect to the environmental circumnstances.

The Italian ryegrass that is used as cover crop can be flooded in winter for 15 to 20 days (USDA Sustainable Agriculture Research and Extension, 2023), after which the grass has to rest for a while. During this time water could remain in a next field and combined with soy fields from crop rotation (or other fields that don't use a cover crop) to allow the water to remain in the fields as long as possible.

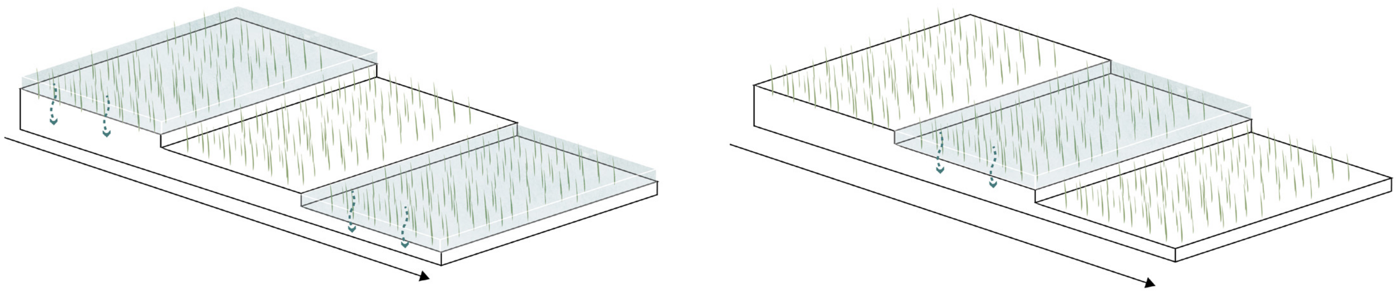


Figure 4.7: Water rotation cycle: organic rice can be flooded for 15 to 20 days, after which the water is allowed to flow into the adjacent field.

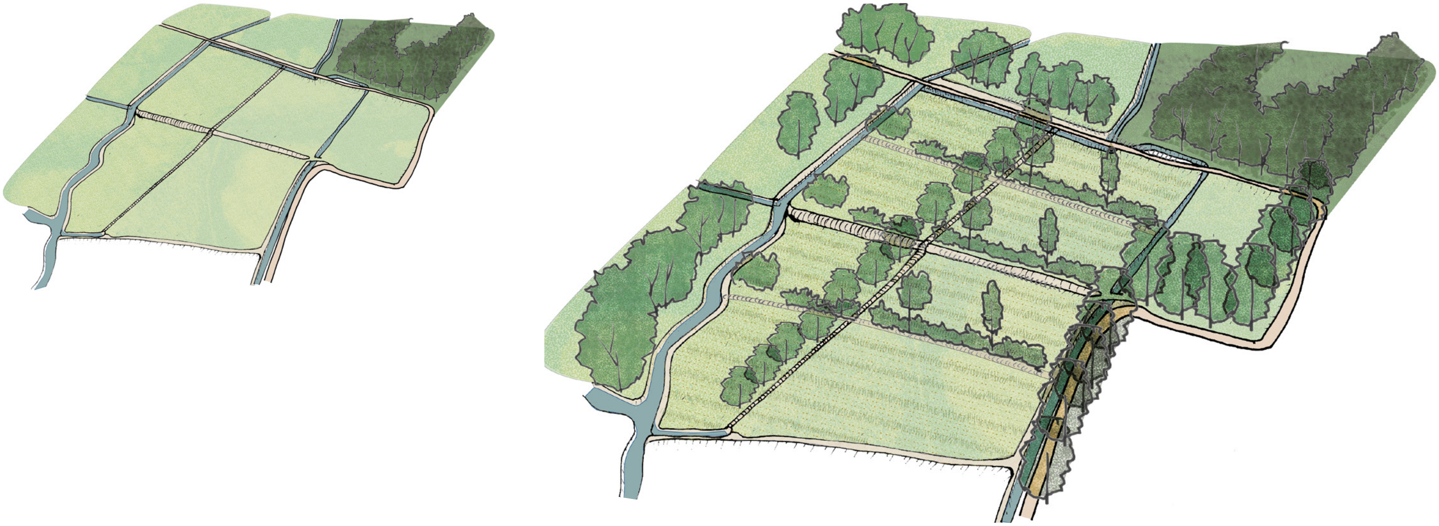


Figure 4.7: Comparison of landscape elements in the current situation (left) to after the application of organic rice (right).

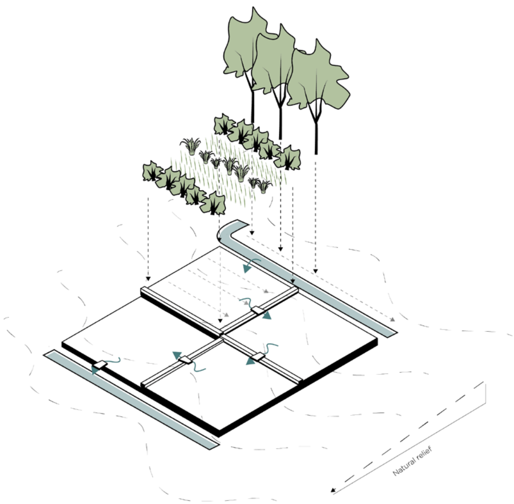


Figure 4.8. The structural elements can be applied on the existing structure of rice production.

Figure 4.9: On a larger scale, the integrated vegetation links together, creating connecting green tissue within the agricultural landscape, further emphasized by the taller trees that line the roads that run through the fields.

4.5.2 Nature friendly banks

The hydrological system composed of the intricate set of canals is one of the carrying structures of the landscape. However, the canals are heavily artificial and lined with concrete slabs or cobblestone, making the canals work like deathtraps for amphibians or ducklings as they cannot get out of the water. Additionally, as pointed out in paragraph 1.2, their rigidity inccrease the water's velocity. To provide habitat, the banks of the canals are to be redesigned where possible into nature-friendly banks. These banks have a gentle slope of 1 : 3, so that aquatic species and birds can enter or exit the canal and for various types of vegetation to flourish. The slope consists of three zones (figure 4.12): most inland, the riparian zone with small brushes and herbs, the marshy zone with reeds and the zone with submerged aquatic plants (Rivierenland, 2024). Maintaining dead and alive reed cover along the borders of the canals is an important factor for bird presence (López-Pomares et al., 2015).

Canals that pass through urban areas might not always allow for redesigning of the banks due to proximity to other structures. Therefore, green quays will be implemented in these locations to still provide opportunities for ecologicy to enter of exit the canals. Primarily though, these would support effects of urban renaturation (GreenQuays, z.d.) and play a role in transforming the now often neglected canalside spaces.

Along its course, adjacent lands are transformed into wetlands and alluvial forests to use the canals as ecological corridors and generate semi-natural habitats, potentially facilitating movement between wetlands (Moreno-Mateos et al., 2008). As a result of these transformations, the flood capacity and water quality can be improved, as well as protection against streambank erosion (Connor, 2023).

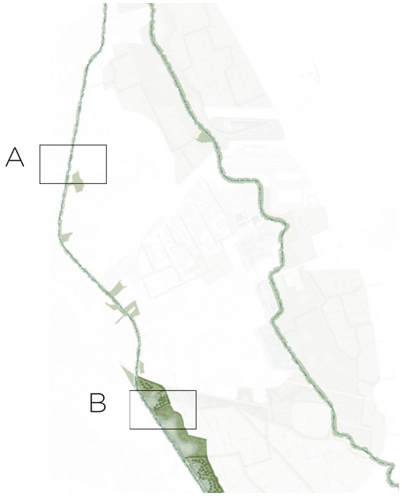


Figure 4.9: Locations of bank transformation suggestions.

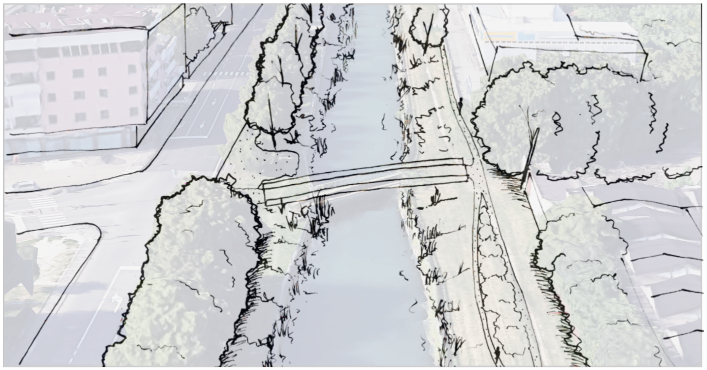
Hard

Soft

Figure 4.10: Hard and soft section of the canals in their current state.
Source: Benny Greco, 2012

Figure 4.11: If complete canal transformation is not possible, green quays can support urban renaturation.
Source: Van der Tol, (z.d.)., GreenQuays (z.d.)

A



B

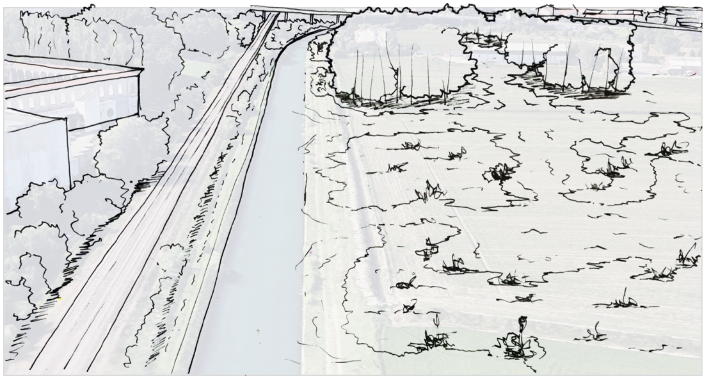


Figure 4.12: Urban (A) and rural (B) canal transformation.

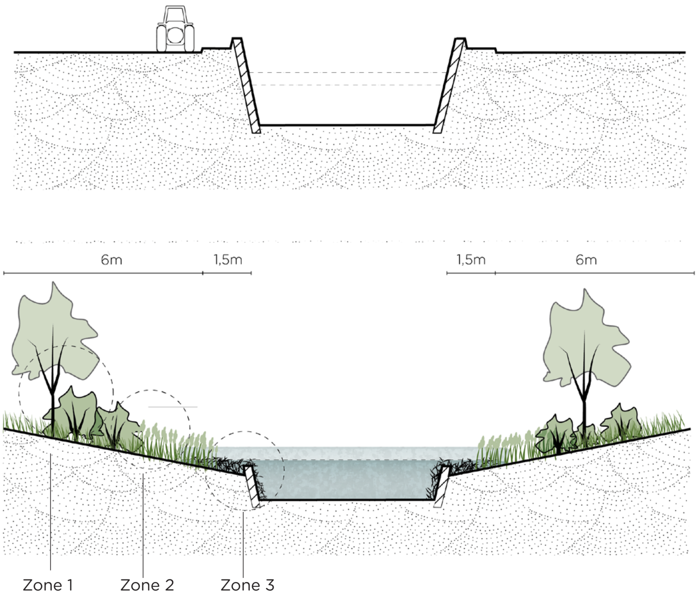


Figure 4.12: Transformation in detail with 3 zones, consistent of the riparian zone, the marshy zone and the zone with submerged aquatic plants respectively.

Figure 4.13: The canals in the hinterlands are connected to adjacent areas which are transformed to wetlands and alluvial forests to slow down water and increase infilration rates

4.5.3 Filtration park

The river Terdoppio enters the city of Novara through two industrial plains. Stormwater runoff from these plains follows the natural relief and ends up into the river, polluting it. By a combination of semi-natural (A.1) and artificial (A.2) ditches, the runoff water from the industrial plains is collected and transported to a primary filtration facility (B). The water requires a primary treatment in order to heavy pollutants like solids, oil and grease.

After, the water enters the subsurface wetlands (C) for the secondary treatment, removing pollutants through a combination of physical, chemical and biological processes. Here, solids gets trapped in soil, nutrients are absorbed and pollutants are broken down, after which it flows to the surface wetlands (D) (Hassan et al., 2021).

The fourth section are the oxidation lagoons, for reoxygenation and slow infiltration of the purified water. Inspiration is drawn from the Weiliu wetland park by Yifang Ecoscapes (Chen & Shao, z.d.).

All three parks are traversable and serve as places for soft tourism, offering visitors insight into the workings of (E) and multifunctionality that can be assigned to water treatment. The integration of the park within the riparian buffer that embraces the city showcases its role in protecting the environment.

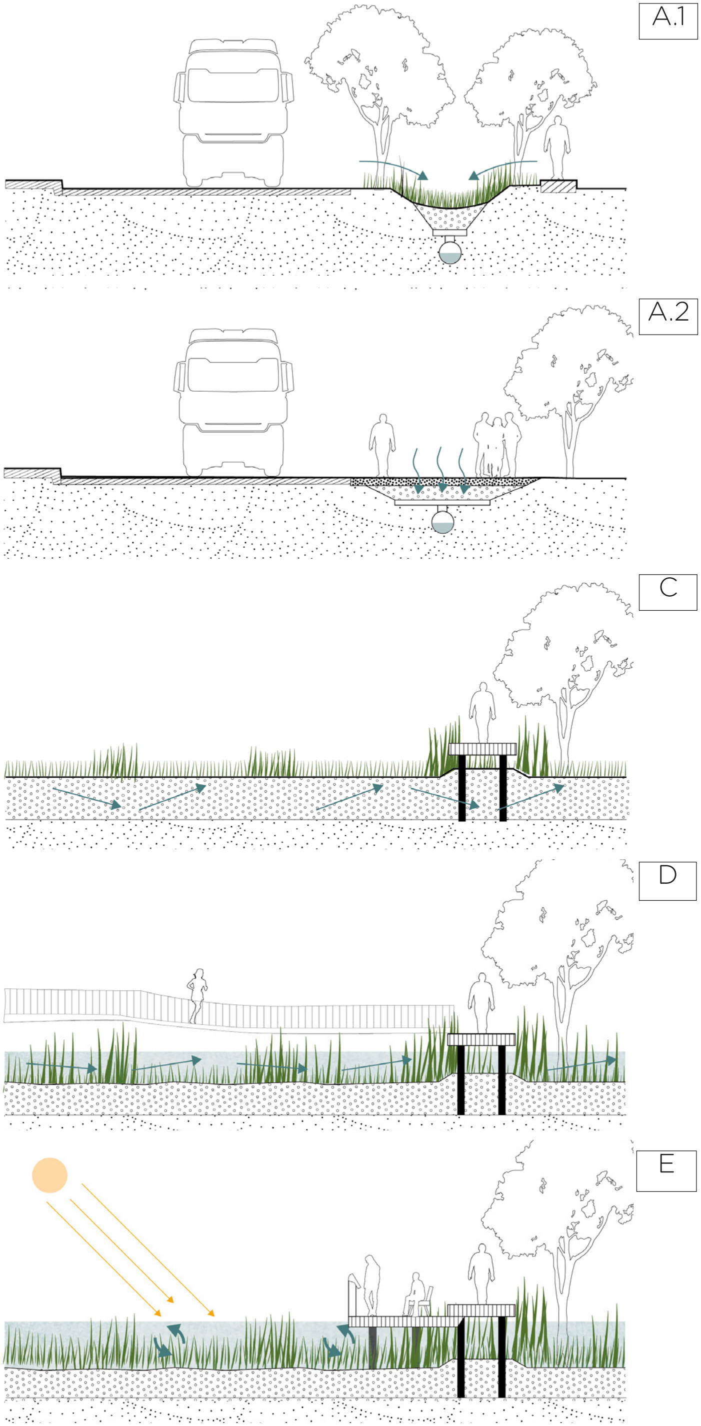


Figure 4.14: Sections of the different parts of the filtration park. In the industrial area, water can be collected through green interventions or permeable pavement, depending on the context of the street.

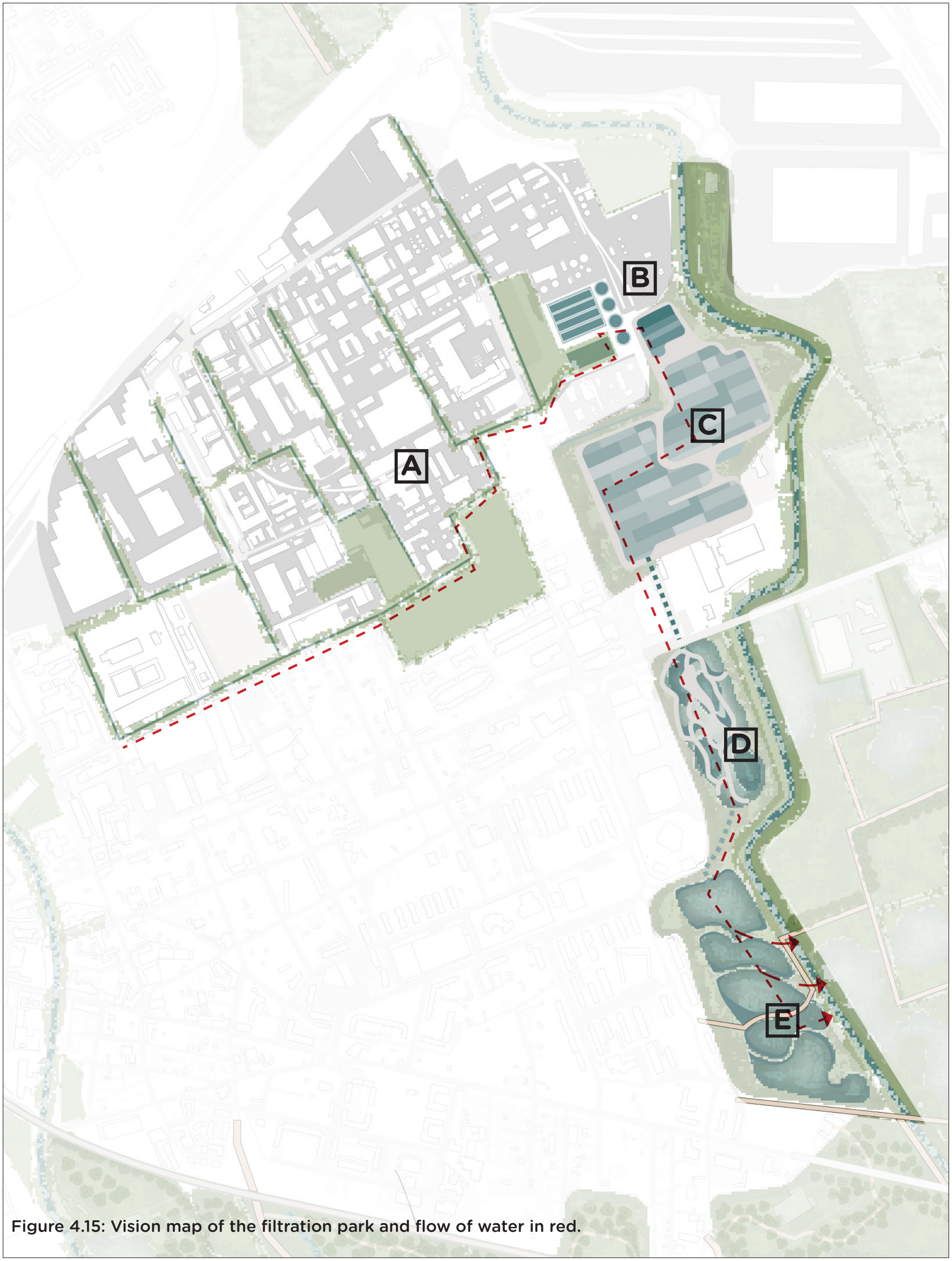


Figure 4.15: Vision map of the filtration park and flow of water in red.

Industry runoff water A

Primary filtration B

Subsurface wetlands C

Surface wetlands D

Oxidation lagoons E

4.5.4 Tidal Park

The floodplains in the area have been defined to be able to hold water in times of intense precipitation, for when the canal or river inundates. From the opportunistic perspective of this design strategy, the floodzones can become multifunctional by transforming to a tidal park with two different inundation zones and corresponding functions. The river can flood directly into these zones, as well as that the river has separate canals functioning as an overflow, tapping river water and allowing it to flow artificially into the fields (figure 4.18). This way, abundant water can be allowed to slowly infiltrate and recharge the aquifer and water table.

The first zone of inundation and in direct proximity to the river is composed of wetlands. Since the riverbanks are transformed to nature-friendly banks, the wetlands are in direct connection with the river, so in times of increased precipitation the wetlands can get flooded. Some routes throughout the wetlands are elevated for soft tourism, making parts of the wetlands traversable in times of inundation, as opposed to other routes that are only traversable during lower water level (figure 4.19). Along these routes, spaces for leisure are combined with information posts that explain how this area deals with water in a conscious way, stimulating engagement and awareness about water use and the need for such internventions (figure 4.16).

The second zone is composed of rice fields which lie slightly higher than the wetlands. Therefore, the wetlands can get flooded without the rice paddy's being disturbed. However, in times of extreme inundation, the rice paddies can hold inundation water as well. The state of the water determines how long the paddies can be flooded to prevent production loss: as such, seedling rice can survive for a month if the water is clean, while for older rice 7-10 days is the max (Hardke & Roberts, 2021).

This system can operate upon the present system of canals and rice paddies. The system of manually controllable in- and outlets allow for the water to enter and exit both zones, providing outlet to fields beyond the borders of the inundation zone if the water gets too high (figure 4.17).

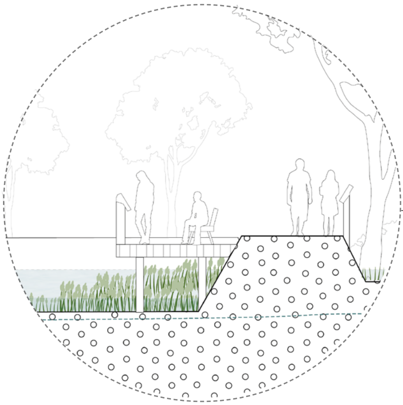


Figure 4.16: The Tidal park in section. Line 1 shows the regular 'tide', wettening the wetlands due to artificial inlet. Line 2 indicates the high tide during

Figure 4.17: The tidal park consists of floodable wetlands and ricefields and has two types of water inlet.

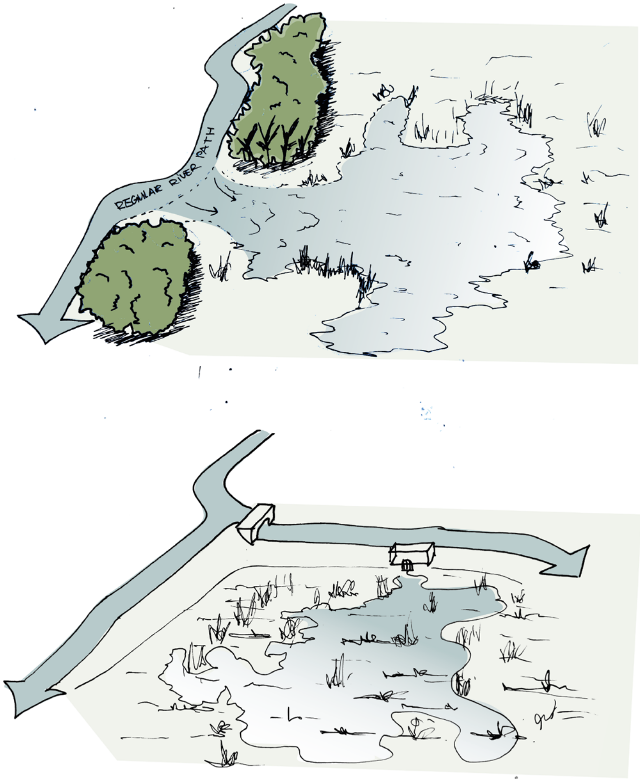


Figure 4.18: Artificial water inlet (controlled) and natural water inlet (safety measure)

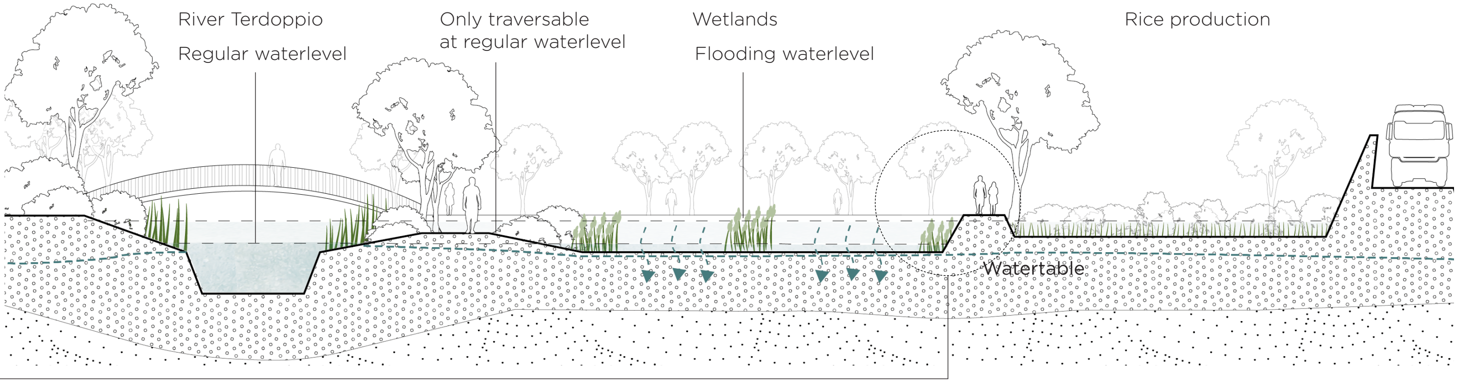


Figure 4.19: The Tidal park in section. Line 1 shows the regular 'tide', wettening the wetlands due to artificial inlet. Line 2 indicates the high tide during times of heavy precipitation. The rice fields are allowed to flood as a safety device.

4.5.5 Urban riperian buffer

The urban areas in the region have a rather direct transition between the built environment and agricultural landscape. Often the residential areas directly border the rice paddies or are merely separated by a road of railroad tracks. The goal of the urban riparian buffer here is to change these harsh transitions into a gradual one, composed of different zones with various types of vegetation. This provides water quality benefits and a peripheral green structure for inhabitants and wildlife alike.

From outside to inside (the urban realm being 'inside'),
the zones function as follows;

1 Safeguarding the physical integrity of the stream ecosystem
Undisturbed forest, flood control, paths
2 Establishing a spatial buffer between urban development the stream
Managed forest, bikepaths, recreational
3 Mitigating the impact of residential runoff through natural filtration processes
Denser vegetation is encouraged
(Dan River Association, z.d; Graff et al., 2005)

The urban riparian buffer coincides with the nature-friendly banks and the filtration & tidal park, which strive towards the same goal as the riparian buffer. On the southern side however, dwellings are bordered by the railroad track, preventing a completely smooth transition. Therefore, the riparian buffer will be designed in surroundings of the railroad tracks, on both agricultural lands as unbuilt urban area.

Figure 4.20: The urban riparian buffer.

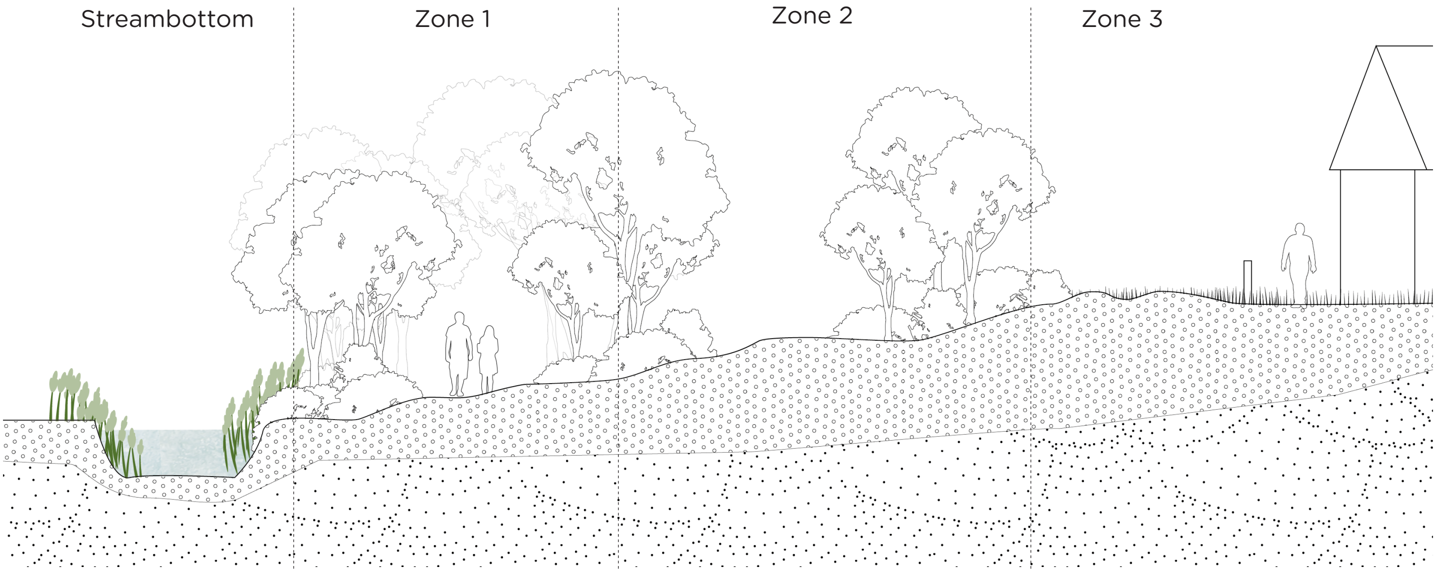


Figure 4.21: The riparian buffer allowing a new, green transition between the urban area and the agricultural hinterland.
Source: By author, adapted from Graff et al. (2005).

4.6 Seasonal dynamics

In spring and autumn, when precipitation is high fields can get flooded, while in winter water is allowed to enter the fields and slowly permeate the soil. If the water is also drained from the soil, a small amount of water can remain on the grass of the cover crop, nourishing it as it adheres a slightly higher temperature than the frigid air and prevents grass to be completely submerged, hence providing crucial forage for birds surviving the winter cold. (link to marcite)

In later spring and summer, when the demands are high but precipitation is low, the water table is still high enough that only little water is necessary to keep the level high enough for rice production.

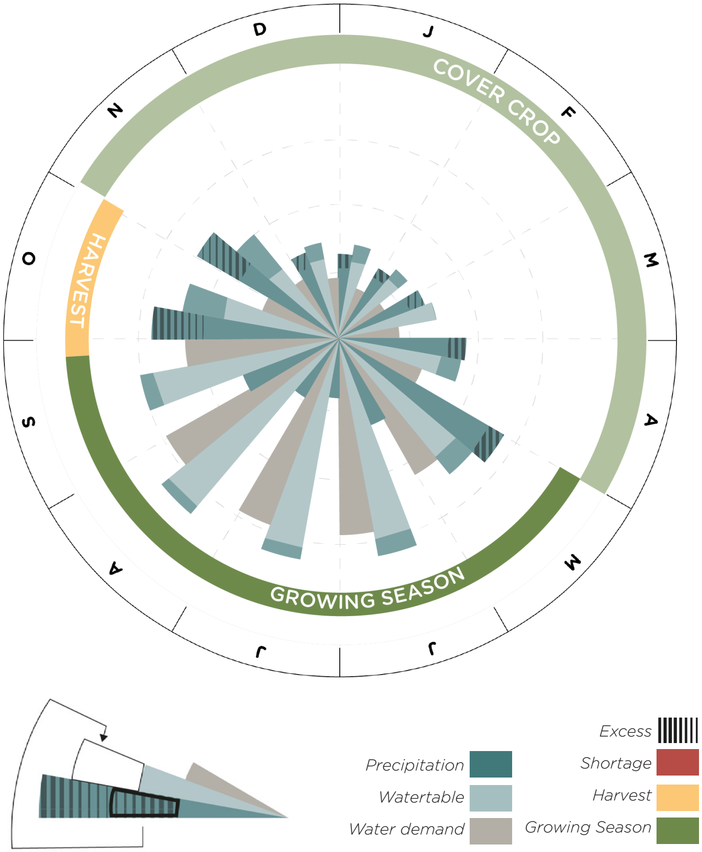


Figure 4.22: The design strategy attempts to work synergistically with the changing water dynamics. Using water in times of flooding for purposes of infiltration and ultimately underground storage, aids to reduce waterstress in times of drought by restoring the watertable and aquifer.

Low water demand (flooded)

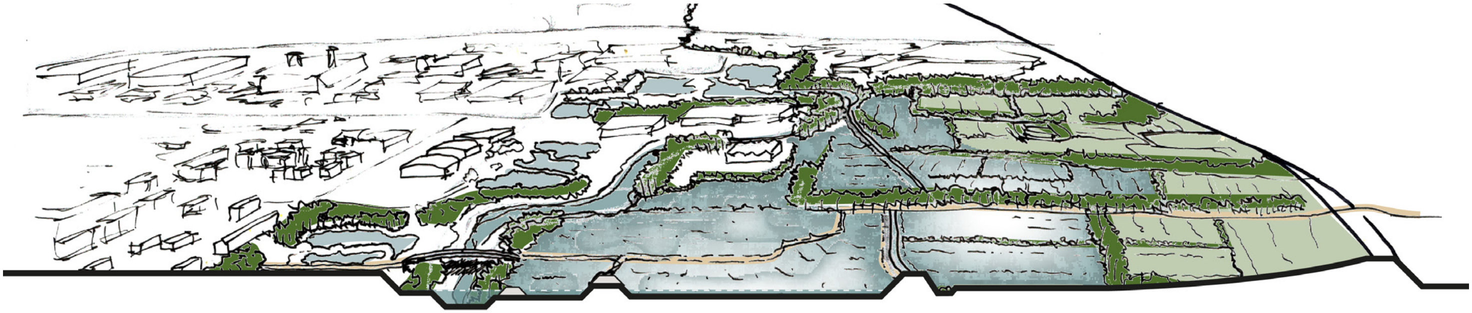


Figure 4.23: The design in times of flooding, allowing the lands to inundate

High water demand (flourish)

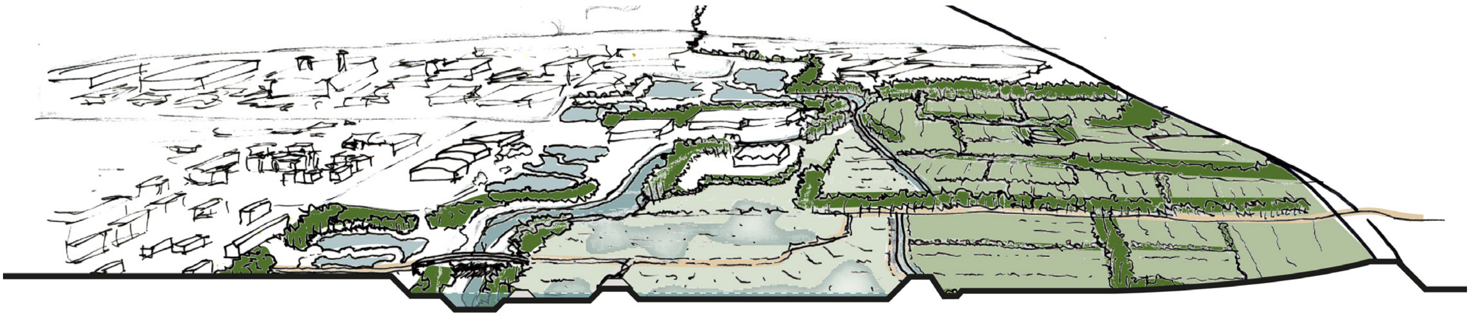


Figure 4.24: The waterlevel in the soil has been recharged and can alleviate the effects of drought in times of precipitation deficits.

4.7 Design synthesis

To reinforce habitat provision in agriculture and enhance water security, the strategy attempts to invigorate the current state of the landscape to accommodate for changing water dynamics. It does so by enhancing present landscape structures or qualities to opportunistically approach the challenges that the region is dealing with. This opportunistic and multifunctional character is crucial, as it shows how safeguarding the health of ecosystems reinforces their resilience to environmental challenges, which can be harnessed to support human development. Furthermore, to spread awareness on this and through that, reconnect people with nature, the strategy and design interventions aim at stimulating engagement of people with the design interventions.

The design interventions themselves work synergistically within the landscape system, creating a network that enhances habitat provision, water security and ecological health. Each intervention contributes to a cohesive system that addresses the region's challenges while supporting biodiversity and sustainable land use.

The strategy considers temporal dynamics by incorporating features that adapt to seasonal changes and varying water levels. For instance, floodable rice fields and inundated wetlands are designed to handle seasonal flooding, reflecting the landscape's changing states over time. This approach promotes flexibility and resilience in response to fluctuating water dynamics.

The interventions positively influence the water cycle by enhancing water retention, promoting infiltration, and increasing groundwater recharge. Nature-friendly banks slow down water flow, retaining it longer in the landscape. The transformation of rural areas into wetlands and alluvial forests further enhances these functions, while urban canal transformations support urban renaturalization and water management.

The design interventions positively impact the local environment, economy, and community by enhancing ecosystem services, boosting biodiversity, and supporting sustainable practices.

Some of the strategies draw inspiration from traditional knowledge and practices, such as reintegrating na-

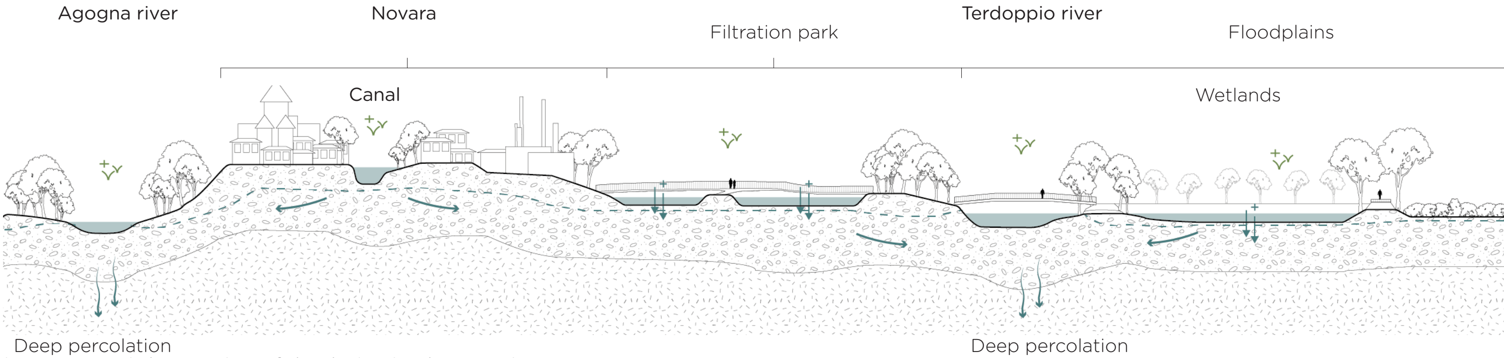


Figure 4.25: Bird's-eye view of the design implementation

ture into traditional agricultural practices (flooded rice), incorporating traditional water management techniques like winter circulation, using larger trees along traditional routes and reintroducing natural wetland features. In doing so the strategy opts to preserve cultural heritage while enhancing ecological performance. To synthesize the design strategy, the interventions are summarized according to the goals stated above.

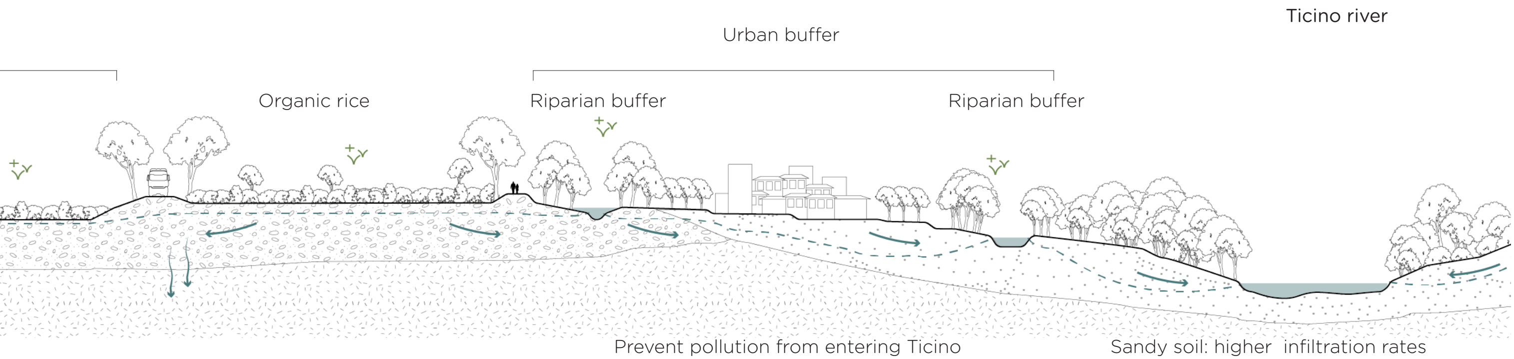
Organic Rice Production:
Integrates vegetation into its structure, forming a connecting tissue of ecology on a larger scale. Roads within the traditional structure are highlighted by larger trees, enhancing visibility and serving as visual stimuli.

Nature-Friendly Banks:
Improve the ecological potential by allowing vegetation for animals to enter and exit canals. The new profile slows down the water, retaining it longer in the landscape. Adjacent lands are transformed into wetlands and alluvial forests in rural areas, while urban canal transformations support renaturalization and connect to rural routes.

Filtration Park:
Offers green space in the form of wetland parks, allowing engagement through zones that explain wetland properties and functions, raising awareness of their benefits.

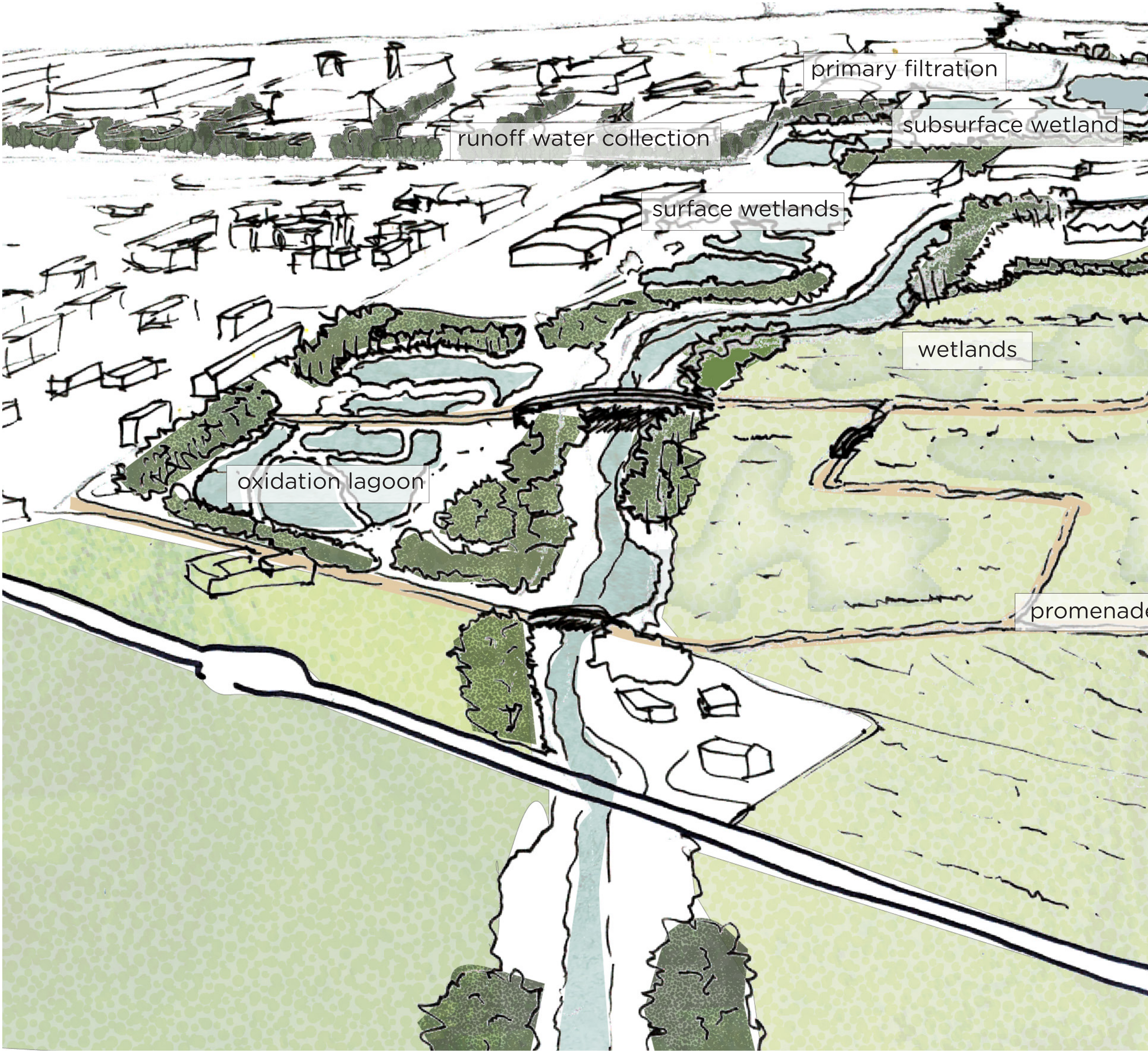
Tidal Park:
Utilizes the river Terdoppio's floodplain to enhance habitat provision and water security, using floodable rice fields as a safety measure during flooding. Routes through the park are highlighted by larger trees, with some paths traversable depending on water levels, showcasing the landscape's adaptability to changing water dynamics.

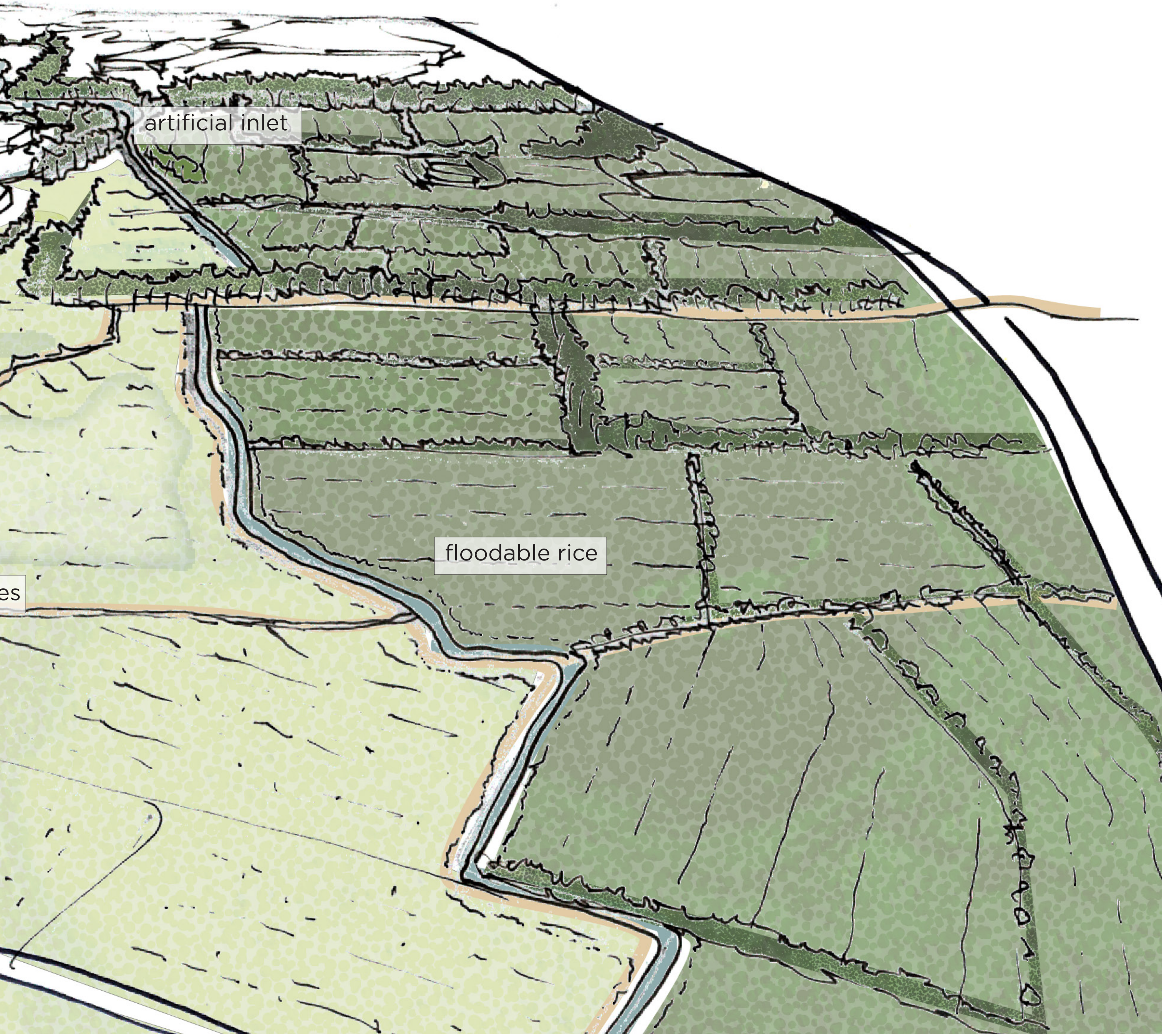
Riparian Buffer:
Provides a gradual transition between urban and rural landscapes, offering green space and preventing polluted runoff. It engages the community by using these fringes as parks and integrating cycle or pedestrian routes.



RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

Figure 4.21: Bird's-eye view of the design implementation





RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

Figure 5.1: The lower Novara area.
Source: Razza77, (z.d.).

5 Conclusion

This paragraph will conclude upon the research- and design questions and the project overall. First of all, a general conclusion of the whole project is given Second, the qualitative effects of the design interentioins are reflected. Third, since the design responds to challenges of a specific context, the challenges in applying the strategy to other locations will be defined to evaluate its transferability

5.1 General conclusion

This thesis began with a statement on the responsibilities and aspirations of our generation of designers, particularly in the context of the climate crisis. This has fueled the inspiration to address urgent environmental issues. Combined with a profound interest in the Italian landscape and culture, this work has explored the intersection of climate adaptation, water management and the intricate human-nature relationship in the context of rice production in Northern Italy, specifically between the Ticino, Sesia and Po rivers.

From the historical context, it is evident that water-management in Italy's Po region has long been dominated by a utilitarian perspective. This perspective has overlooked the complex ecological roles of water systems and has focused on water as a resource for human use, often at the expense of the natural resilience of ecosystems.

Recognizing the critical importance of water for both human well-being and ecological health, this thesis argues for a paradigm shift: from exploiting water as a mere resource to understanding and managing it as a vital component of resilient ecosystems, essential for supporting sustainable human development. This has lead to declining water availability, exacerbated by climate change and threatening the agricultural production of water-intensive crops like rice. The traditional exploitative mindset towards nature has resulted in practices that deplete water resources and degrade ecosystems, making it increasingly difficult to ensure sustainable agricultural production.

"

How to provide water security for rice production fitting to evolving water dynamics while improving the connection between humans and nature in the paradigm case of the Ticino, Sesia and Po river?

"

This thesis posits that water management strategies can and should be designed in harmony with natural processes. The hypothesis was that reinforcing water management in this way can benefit assuring nutritional demands and improve the human-nature relationship. This is supported by drawing from theoretical perspectives on the human-nature relationship, highlighting the importance of understanding the perceived separation between humans and nature. By fostering awareness and engagement, people can be encouraged to make environmentally considerate choices. This supports the practical approaches suggested later in the design strategy, which include traditional water retention techniques, habitat restoration, and integrating ecological considerate practices into agricultural practices.

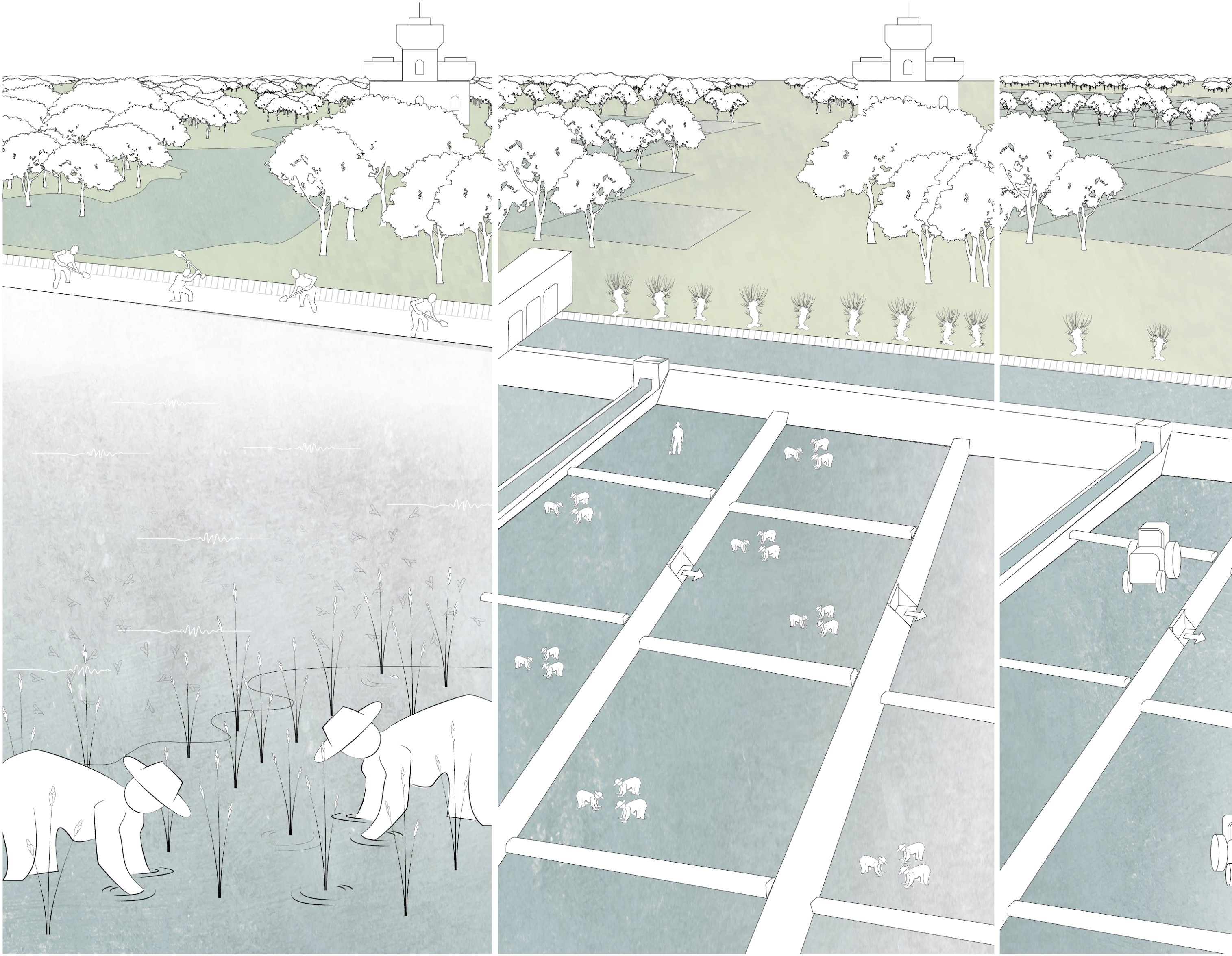
> “
> *How can design reinforce habitat provision in agriculture, enhance water security and improve the human-nature relationship in the urban rural context of Novara?*
> “

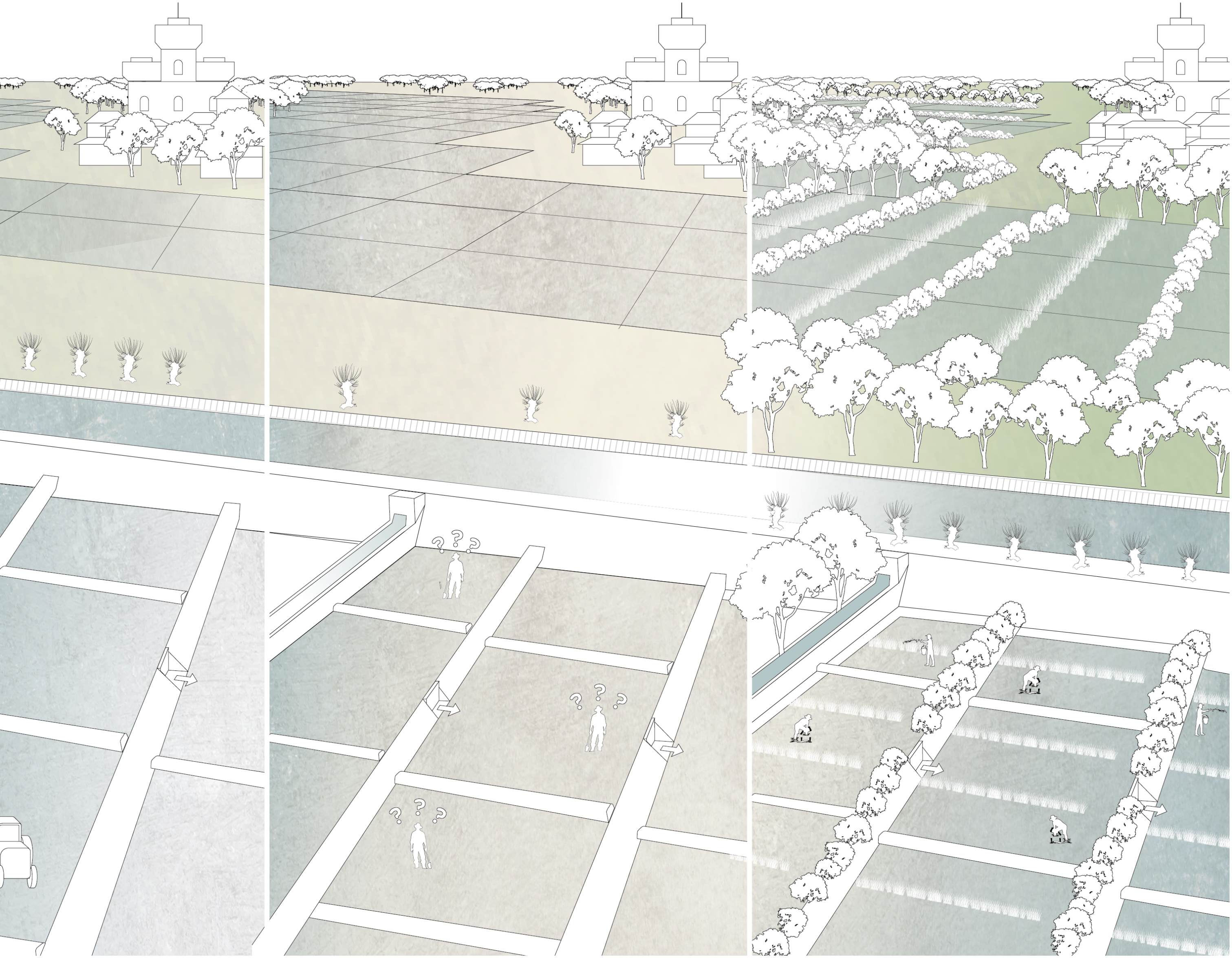
To address these issues, this thesis recommends a return to traditional flooded practices in rice production to maintain a balanced water cycle.Additionally, it proposes reintroducing or creating new water management concepts that utilize abundant water and store it underground, helping to retain water in the landscape. Restoring lost habitats and creating new ecological structures within agricultural systems can compensate for the ecological degradation caused by intensive farming practices. These actions allow for an opportunistic respond to changing dynamics of floods and droughts.

Finally, to improve the human-nature connection, it is essential to raise awareness about the workings of these interventions and encourage active engagement with the cultural landscape and natural environment. To this purpose, the design interventions can work multifunctionally to provide socio-economic benefits. This is present in the way that the tidal- and filtration park provide qualitative green space for leisure, varying in character throughout the seasons, or how the now naturally strengthened rice production landscape reinforces the tourism routes and recreational activities. The qualities of the resulting landscape can strategically leverage people’s emotional connections to the (now naturally enhanced) cultural landscape, promoting a more harmonious relationship with nature.

In conclusion, this thesis stresses the need for a holistic and integrated approach to water management and agricultural practices. By fostering a deeper connection between humans and their environment, through implementing practices that support ecological health, the resilience and sustainability of the rice production landscape in Northern Italy can be enhanced. This work not only addresses urgent climate adaptation needs but also contributes to a broader understanding of the need for sustainable agricultural practices and restoring the vital bond between humans and nature. The insights gained from this study can inform future policies and practices, ensuring a sustainable and resilient future for the rice production landscapes of northern Italy and beyond.

Figure 5.1: Imagining the continuation of landscape transformation





RICE: Climate adaptation strategies for the rice production landscape of Northern Italy: the context of the Ticino, Sesia and Po rivers.

5.2 Transferability

While the project's holistic and integrated approach to water management and agricultural practices offers valuable insights, its transferability is challenged by the specific properties of the region, economic and social factors, institutional and policy frameworks, technical adaptability and environmental considerations. Addressing these challenges requires careful adaptation and contextualization of the project's strategies to fit the unique conditions of different regions. The following themes are most important for the transferabiliity of this work.

Climate and geography
The strategy is tailored to the specific climateic geographical conditions of the Novara area. Transferring the interventions to other regions with different climates, rainfall pattersns and soil properties might require adjustments

Environmental considerations
The ecological systems in different regions vary significantly. Strategies that are effective in restoring and maintaining the ecological balance in the Po region may not have the same impact in different ecosystems.nAdditionally, the specific impacts of climate change, such as changes in precipitation patterns and temperature, differ between regions. T

Infrastructure and technology
Some interventions are applied to existing (agricultural) infrastructures, therefore they might not make sense in an area in which these are not present.

Cultural context
The project integrates the unique cultural and historical context of the Italian landscape, which might not be directly applicable or relevant to other regions with different cultural values and historical practices in water management. Since rice production is highly valued in Italian culture, enhancing the experience of the landscape fits well with leveraging people's emotional connection with the landscape.

Socio-economical context
Reinforcing habitat, enhancing water security and improving the relationship between humans and nature are terms that are hard to measure but are the core focus of the strategy. However, in addressing the human-nature connection, the design interventions strive to raise awareness on and increase awareness of the way that they work. Through encouraging people to engage with these interventions, the design attempts to help people become more aware about the environments' declining health and the importance of these interventions. It aspires to contribute to a paradigm shift on how we manage natural resources, however this paradigm is connected to the projects context. Other situations might adhere to a different perspective, be it in a positive or negative sense. The socio-economical context of a location severely influence what kind of interventions would or would not work, and how easily inhabitants are influenced by these kind of interventions.

Agricultural practices
Local agricultural practices and crop types vary, which means the techniques proposed for rice production in Northern Italy may not be directly applicable to regions growing different crops with different water needs.

In summary, the direct transferability of the design is challenged. The concept of more sustainable perspective on agricultural practice and adressing complex environmental challenges however is transferable, but it will always need expert knowledge and experience to define its approach.

5.3 Final considerations

“There is sound scientific evidence for climate change, but measuring its effects is not an exact science”

Dr. Marie Juanchich in (University of Essex, 2018)

In evaluating and concluding upon the research and the strategy, it is necessary to take a critical position to the choices that have been made. One of my major challenges in this project was being able to frame the incredibly complex subject of agriculture with its social, economical, environmental, cultural and political themes. To be able to do this, certain positions have been taken and considerations have been made.

Two minor consideration are on the subject of water extraction. Industries and the water they extract from the soil are not taken into account in this project, however in reality their pressure on underground water sources cannot be removed from the equation, potentially lowering the watertable and negating the system changes that the strategy attempts to make. Drinking water extraction is also not accounted for, however for both of these counts that soil remediation through increased ecology and continuous recharging of the aquifer positively influence the quality and quantity of the deep drinking water sources.

This research opts for the preservation of rice, through considering it fundamental for the preservation of a unique cultural landscape with important environmental and ecological services.

On the other hand, rice production, through its method of flooding and the anaerobic conditions that it creates, is responsible for 10% of global Greenhouse Gas Emissions from agriculture, which translates to 1.3% of all global Greenhouse Gas Emissions. Compared to the what other staple foods emit per ton of protein, like as animal-based food, this is very little. However, the emissions from anaerobic conditions consist primarily of methane, which is 25% more effective at preventing radiation from leaving the atmosphere than CO2, although it also disappears quicker (Fleming, 2019; Held, 2023).

With the climate effects of flooded rice in mind, it becomes all the more interesting to realize that flooding is essential for rice to grow. Instead, it was primarily found to be very effective in combatting rice’s feared weeds. Sean Fleming describes in his article “This is how rice is hurting the planet” (2019) that farmers are simply so used to the method that no other methods have prevailed for a lack of imagination.

According to specialists of the Asian Development Bank (2023), who organized a seminar on “Reducing Methane Emission in Rice Farming in Asia”, other techniques such as Alternate Wetting and Drying (AWD) can reduce water use and methane emissions without losing yield. Continuously new methods of rice production are being researched, in hope of finding methods that use less water and emit less greenhouse gasses. Although AWD might lead to fewer greenhouse gass emmissions, the Piemontese landscape needs high rates of infiltration to preserve the characteristic and ecologically valuable landscape.

Further research is necessary to find a balance in how much of what practices should be applied to alleviate the various themes that experience pressure. Nonetheless, as this project points out, the territorial properties are a key determinator for which practice should be applied where, attempting to justify the prioritization of certain themes.

Regarding the method of organic rice, although research is necessary for improvement, it provides an example of a method that bring the production of food and its environmental effects in closer connection to health. Not solely in regard to environmental health, but also to that of consumers , since organically grown rice removes pest- and herbicides from the equation, therefore producing healthier food compared to many other nutritional sources of the present day. With great respect for his words and for lack of my own, I would like to quote Luca Ghiardo, based on Stephen Gliessman's work (1995, pp. 45-47, as cited in Ghiardo, 2023) to illustrate why, through the use of organic rice, the relationship between humans and nature can be improved.

> *" In this sense, a model of agriculture emerges for both currents of thought which must, in addition to developing techniques aimed at the production of food, overturn the paradigm of "domination over nature", which has reached the extremes of an industrial agriculture which treats the land as an inert support on which to impose intensive monocultures through a massive supply of synthetic chemicals such as fertilizers and pesticides, to embrace an agroecological model characterized by greater integration between man and the nature of the territory in which he operates, creating agricultural systems in where the use of external resources is minimized. "*

As a final note to this, the text continues with a farmer which he interviewed, explaining how "the human element" is essential in organic farming, as there is no standard to it and every farmer has their own way of doing it, therefore organic farming reflects a way for humans to get more in with nature again.

In relation to the quote on the previous page by Dr. Marie Juanchich, we do not know exactly what the climate is going to do, how the precipitation is going to change, if snow in the alpes will be completely lost or how much more intense rainstorms wiill become. We can simply not predict the future. Therefore, in design, it is paramount to offer flexibility. It is in the nature of nature to offer elasticity, a certain resilience in dealing with extremities and being able to recover. Thus, it is this flexibility what should be at the core of design, inspiring an attitude of not knowing the exact future, but being able to accept and cope with uncertainty nonetheless.

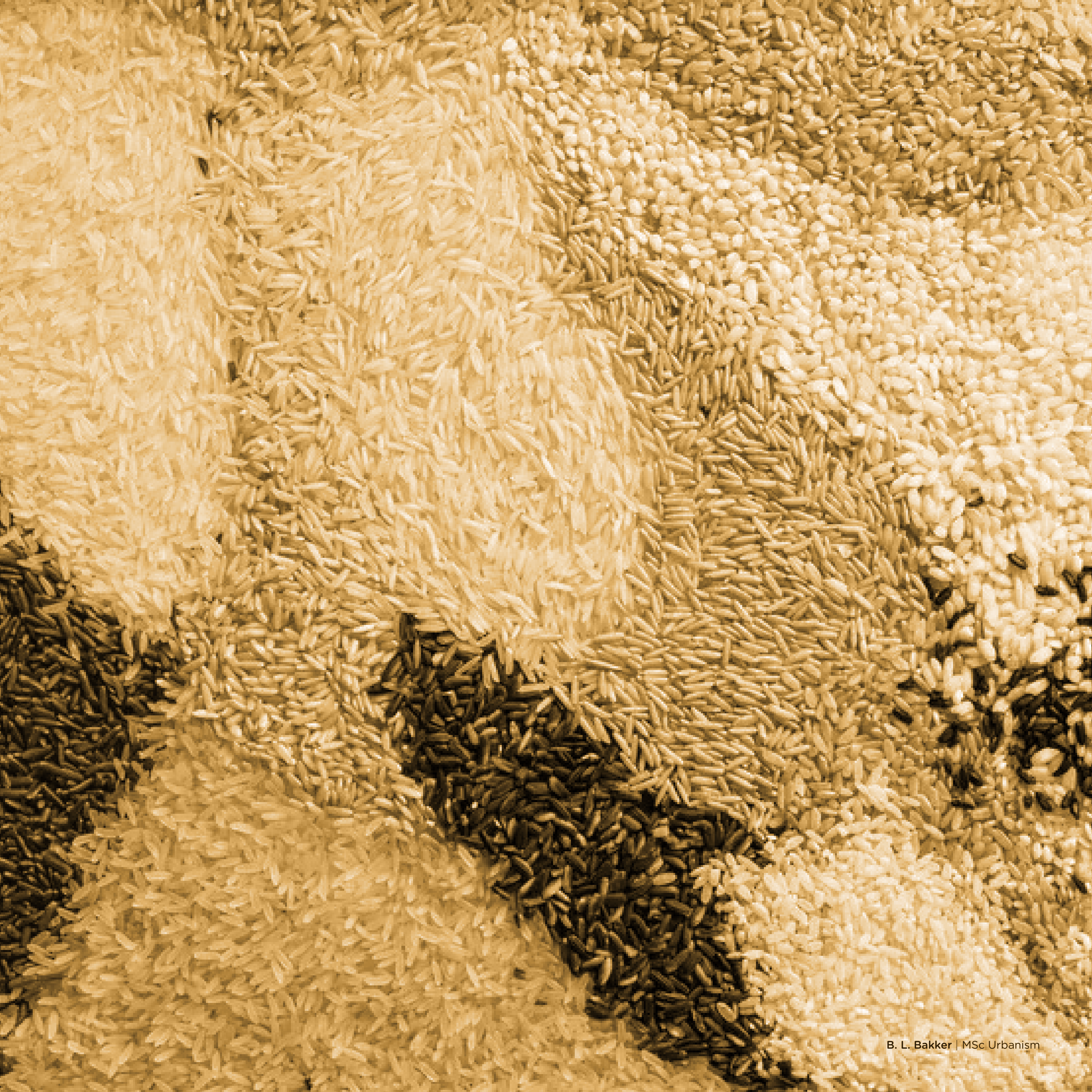


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Figure 6.1: Comparison of rice
Source: Wasik (2023)

6 Reflection & Acknowledgments

This paragraph reflects on the social, ethical, political and scientific relevance of the project, the outcome and the considerations that have been made. It provides an answer on how the aim of this work aligns with the objectives of the mastertrack and graduation studio, how the research has informed the design, and what ethical issues are addressed in this research.

6.1 Reflection

Graduation studio and master track

This work attempts to bridge design and policy by action research and defines challenges in a specific environment.
It provides and implements solutions for these challenges and through this, strive for positive change (Villegas, 2024). Through design, it combines knowledge from different practices in reaction to global challenges like climate change and water & food security. It strives for sustainable organization and management of the urban and rural landscape and raising awareness for an alternative way of dealing with our environment, lining up with the objectives of the Master track Urbanism (Faculty of Architecture and the Built Environment, 2023).

The research and design study was performed in the graduation studio '*Metropolitan Ecologies of Place*', which aims at developing comprehensive ecological design strategies and methodologies to address socio-economic and ecological challenges. This work does so by transforming space to adapt to climate change and water dynamics, while addressing the restoration of biodiversity. Finally, the project also incorporates Circular Water Stories, building on the relationships with traditional water systems and their function in both territory and society.

Interaction research & design

Looking back, the research initially informed the design to a large extend. Starting from my interest and aspiration in climate change, water management and the Italian context, the research slowly converged deeper into the landscape and guided me towards the water dynamics of the Po river and rice production. However, since I felt like I did not acquire enough knowledge yet, I picked the Ticino river as a paradigm case to better understand the dynamics between the riverscape and agriculture.
In doings so, I uncovered that to understand the system of rice production, the boundaries of the Ticino river where simply too constricting. This urged me to revise my perspective on the region in the way that it is incorporated in this project; bordered by the river Sesia, Ticino and Po.
These provided me with more sensical boundaries than those I adhered to previously (the Ticino river catchment boundaries).

Secondarily, I uncovered that the direct riverscape of the Ticino river was much less directly linked to rice production since it is considered a nature reserve, than that of for example the river Sesia, of which the floodplain conincides with agricultural practices. Finally using hand drawings to substantiate the research I did, provided me with an understanding of the landscape and its water dynamics and the critical influence of rice production on both of these.

This led me to the design on the meso scale, on which the challenges and needs of the landscape informed me to research various interventions to relieve pressure in these locations. The research into the structural elements of the cultural landscape informed what kind of interventions these were, since the focus lay on reinforcement of present characteristics. Integrating these interventions into the urban-rural context urged me to further investigate how these interventions work in detail, to be able to design their implementation and how they deal with site specific circumstances.

Methodology

The primary method that has been applied in this project was that of research by design, which is a very effective method in applying interventions to varying contexts and parameters since there is not one absolute design.

to nurture that which can provide the flexibility to cope with the effects of climate change.

Furthermore, the method allows for various design strategies that strive for the same goal but differ from each other due to the context and secondary themes they are combined with, providing flexibility even in design choice.

However, my approach to this method lacked in its efficiency through my own struggle in performing research by design. While losing myself in the theoretical exploration of the convoluted and intertwined themes, I found myself stuck in a loop of requiring a frame to be able to properly carry out the research but requiring more research to define the frame. Out of fear for not drawing on either the right scale or the right theme, I found myself repeatedly diving back into research, hoping that it would provide me the "correct" frame. This feeling of being lost has for a very long time been an obstacle in my design process, until I finally found the courage to dive into the iterative process of research by design by drawing, reflecting, picking a new theme or scale and drawing again, accepting that finality was not yet of the issue. Doing so allowed me to finally grasp the complexity of the territory, providing me with a sensible frame.

Relevance

The multifaceted character of water, in actually any context, makes the project very complex as I noted during my research. As mentioned in paragraph 5.5, some elements are deliberately not considered in the design, since it became too complex for the limited timeframe of a master thesis.

On an economical and political level, decisions regarding water are taken in consideration of parties that have a large influence, such as certain industries. Individual farmers are considerably heard less compared to large corporations and get overshadowed in times of water scarcity.

Additionally, managing water in favor of agriculture and nature like the strategy suggests, demands political support to achieve. This means support would place agriculture above industrial demands, giving the previously mentioned argument a political aspect as well. As research pointed out in the beginning, the responsibilities regarding management of and responsibility over water, are already very complex and ambiguous between municipalities, regions, and provinces alike. Being able to manage water uniformly requires a major transformation on an organizational level to which a completely separate study can be devoted.

Also, the insights gained from this research might inform policy in the way that the position of the farmer might require re-imagining. A position in which a taking care of the landscape is a rewarding practice instead of a costly obligation. This is further elaborated in the following paragraph and under *ethical issues*.

On a societal level, this work highlights the need for a paradigm shift in how we manage our landscapes and natural resources. It provides an alternative to the capitalist paradigm that has influenced the agricultural landscape, resulting in monocultural over-intensification. It attempts to encourage a broader understanding of sustainable (agricultural) practices to improve the relationship between humans and nature. Through raising awareness and stimulating engagement, the strategy attempts to illuminate that safeguarding ecological health means to reinforce its resilience, which can provide the protection against environmental challenges we are so desperately looking for.

This relates to the role that we as designers can inhibit. Our role is significant yet often restricted; however, it is through imbuing our spaces with specific values that we can inspire positive change. Through design, we can inspire humans to reflect upon their view on and position within nature.

Of course, as Manieri (2016) reflects in their work, it might be hard of near impossible to change peoples perspective of nature. Encouring them to engage with nature however might nudge them into making environmentally considerate decisions.

Academic value can be found in how this strategy inspires positive change within the themes of climate change, food production and health and by approaching interventions in a multifunctional and opportunistic way. The unpredictable nature of climate change forces us to think in new, flexible ways. It is through the demonstration of flexibility in these interventions—capable of addressing diverse situations—that multifunctionality can be effectively implemented. This approach imbues specific areas with different values and fosters a different mindset towards addressing climate challenges.

Ethical issues

This research opts for the conservation of rice, through considering it fundamental for the preservation of a unique constructed landscape with important environmental and ecological services. A critical perspective on this ambition is included in the paragraph 5.5 on final considerations.

The perspective from which this work was written, partly through personal beliefs, critisizes farmers' decisions for certain practices in favor of economic revenue, due to their deteriorating environmental effects. However, organic farming is also vulnerable, requires lots of effort and continuous adaptation and we should not forget that we are debating on the source of a farmers' income. Even though this work highlights the need for more sustainable practices; if change is to be achieved through a transition in agricultural practices, then this way should be paved together with them. As research on and attempts at organic farming point out, the knowledge and experience of farmers is crucial in the application and adaptation of practices in their context. The conversations with farmers in the vicinity of Novara and Vercelli offered a hopeful perspective on this issue: they revealed that farmers' shared a feeling of adaptability, even when it is unsure what they will be adapting to.

One of them mentioned that hypothetically, they will not be able to grow rice anymore at a certain point in time, but he was sure that they would find another crop or method of production to transition to, since adapting to the landscape is in the nature of farmers. If research on organic rice practices continues to identify the most effective methods, and if farmers receive support during their transition, they appear willing to adopt these new practices. Given the suggested willingness of farmers to adapt, a paradigm shift could be envisioned where farmers—many of whom already undertake this role with minimal compensation—become keepers of the landscape. In this sense, farmers could subsidies based on the ecological performance of their land, further stimulating ecological performance within agriculture. This requires however a revision of the role of the farmer and their source of income.

Transferability

As is already referred to in the conclusion, wider adoption of the strategy heavily depends on the characteristics of the landscape and the demands of the agricultural practice it is applied to. Adaptation is necessary to suit different climates, ecological systems and agricultural practices. Environmental considerations and climate change impacts vary by region, requiring tailored strategies. Local cultural contexts and existing infrastructure also influence the applicability of interventions. Overall, while the concept of sustainable agriculture is broadly applicable, it requires expert knowledge and contextual adaptation for successful implementation

Complexity

With regard to earlier feedback and important elements of the project, as has been mentioned multiple times before, the region and the different dynamics provide the project with high complexity. Now, hand drawings, something I started to work with extensively, contain and convey this complexity quite well. However, in translating those drawings into digital versions lies the danger of losing that complexity, which is a shame since the complexity is what makes the project unique. Using research by design has allowed me to capture this complexity and on a personal note, rediscover a lost passion of drawing by hand.

6.2 Acknowledgements

I would like to express my deepest gratitude to several individuals who, over the course of the year, provided their knowledge and expertise, and without whom this thesis would not have been brought to completion.

First and foremost, I would like to thank my mentors, Daniele Cannatella and Luca Iuorio, for their invaluable dedication and guidance throughout the development of my work and their sheer patience in navigating me in my chaotic ramblings. Through their perseverance and kindness, they have helped me confront and overcome my fears and insecurities, unlocking a passion for drawing from a place of fear and allowing me to grow both personally and professionally. I am happy to admit that I will miss our inspiring discussions on complex system thinking, and would like to emphasize my admiration for their critical yet encouraging attitude towards my work, which has continuously pushed me to further develop and refine my skills and further discover and pursue my passions.

Special thanks to Cecilia Furlán and Daniela Maiullari for their unwavering enthusiasm and commitment to the Metropolitan Ecologies of Place studio. Their support and involvement with the students and their work have been essential in the studio bond and fostering a stimulating studio environment.

Furthermore, I am deeply grateful for the hospitality and warm welcome extended to me by Domenico and Antonella Marchetti. They invited me with open arms, sharing their passion and introducing me to rice production in the area, which in turn fueled my own enthusiasm and passion for the project. I am thankful for their ability to make this highly complex subject tangible and for showing their deep kindness to a stranger. Additionally, I would like to thank Daniele Clarichetti and Cesare Tromellini for sharing their knowledge and assisting me during my field research.
I am also deeply grateful to my parents for their constant support and positive encouragement, especially to my father for his linguistic assistance in bridging the language barrier while visiting farmers in Novara and Vercelli, as well as for his ever-increasing enthusiasm and assistance with the project.

Finally, I am thankful for the friends I have made over the year. Sharing rocket-fuel-filled coffee breaks with them has made the low moments bearable, the high moments more enjoyable, and the overall process so much more than a learning experience.

Mille grazie.

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