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.

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Metropolitan Ecologies of Place studio

21 of May, 2024

CONTENT

Introduction

Context

Problem, question, method

Research

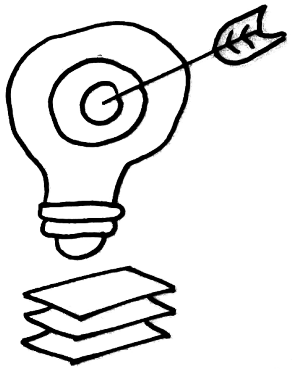
How does the research inform design

Design strategies

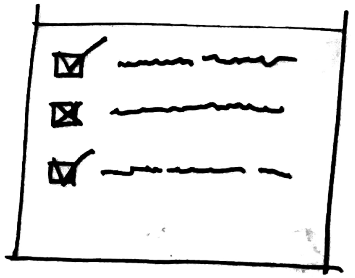
Goals

Context

Design



Final considerations



Global crises

POPULATION GROWTH

CLIMATE CHANGE

RESOURCE DEPLETION

CONSUMPTION

FOOD SECURITY

Sources:
Amante, A., 2023c,; Enviro Editor, 2018; Population Media Center, 2023.

Staple foods

rice

maize

wheat

Sources:
Briggs, z.d.; The Editors of Encyclopaedia Britannica, 2024; King, 2023; New Food, 2021.;

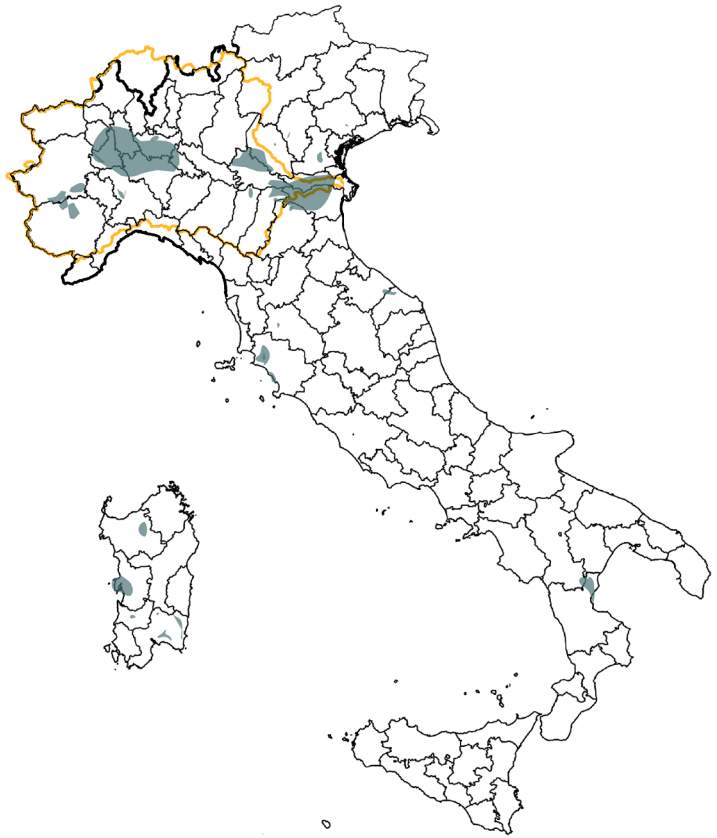
Sources:
Thompson (2013)

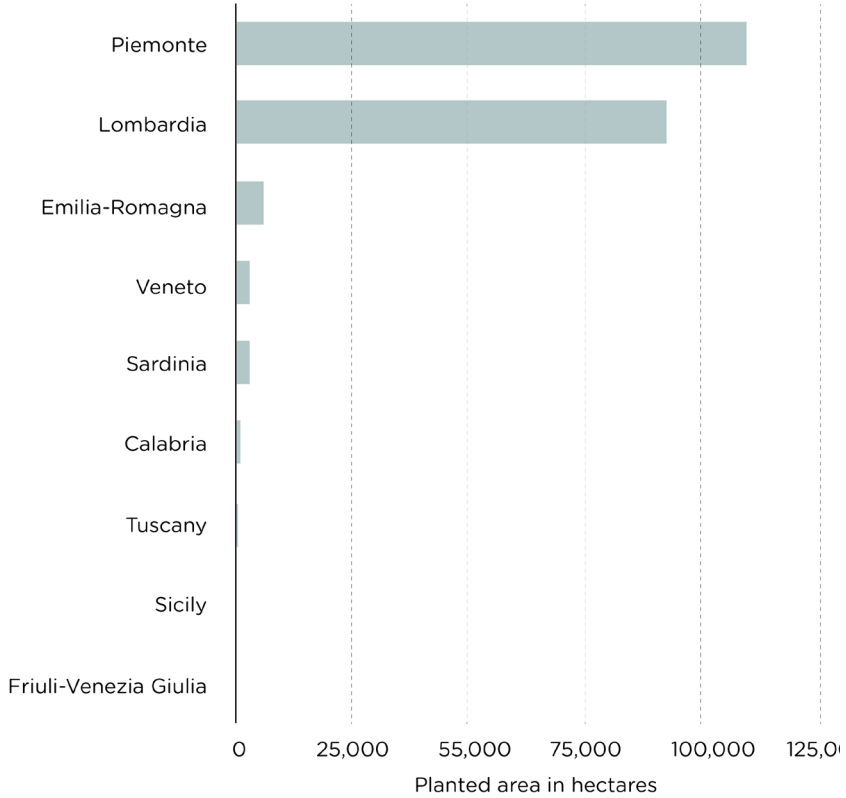
Sources:
Phelan (2020)

Sources:
Farr, (2022)

Sources:
Ward (2023)

Concentration of rice:
National scale





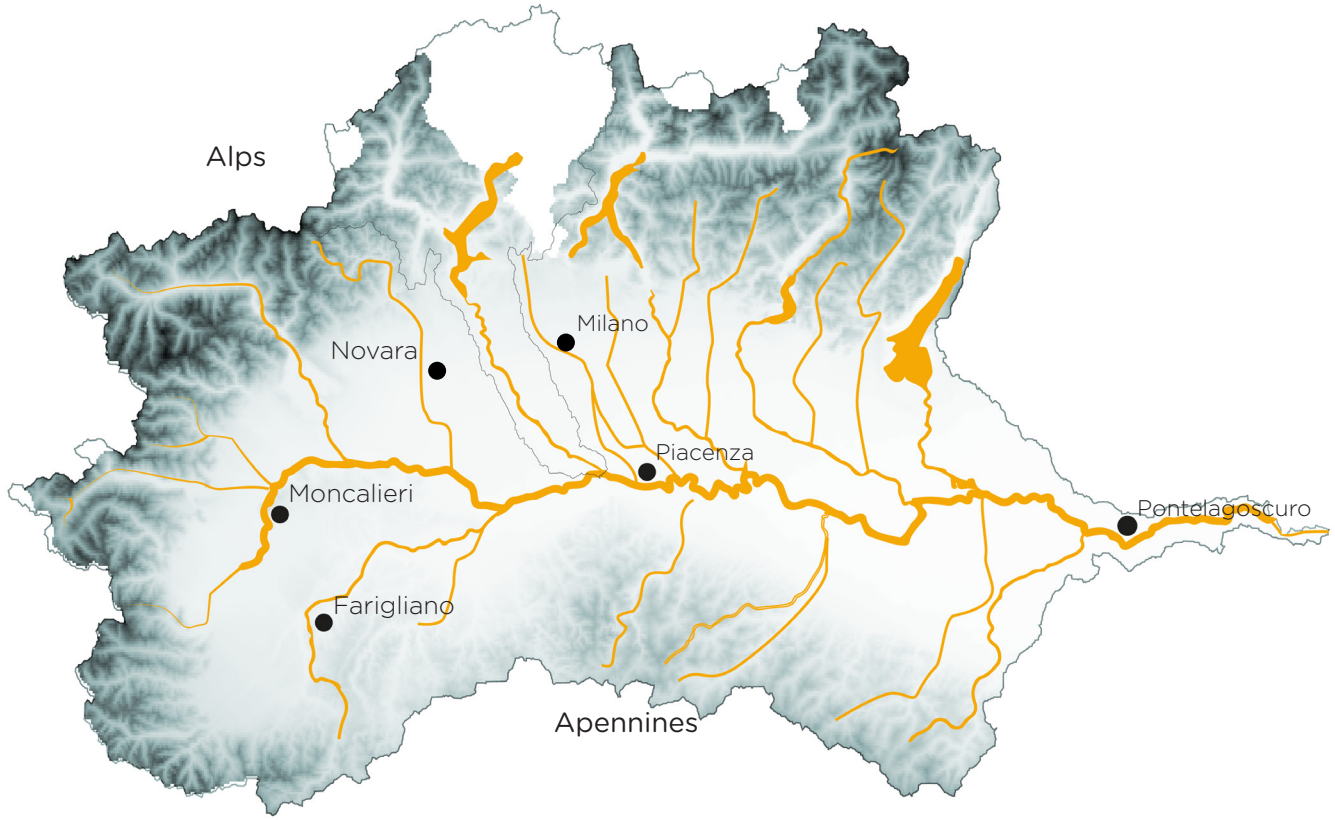
Sources:
Adapted from Lupi et al., 2010; Ozbun, 2022

Climate of the Po valley

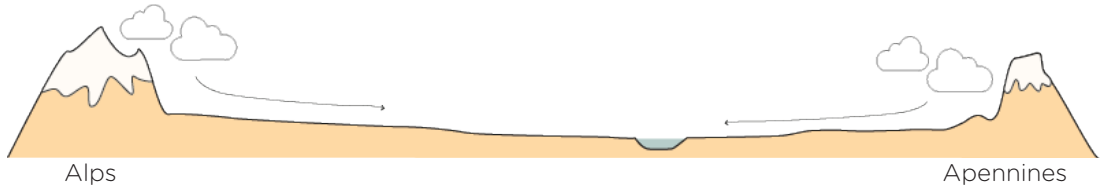
- temperate, no dry season, warm summer
- cold, no dry season, warm summer
- cold, no dry season, cold summer
- temperature, dry & hot summer
- arid, steppe, cold

Sources:
Adapted from D'Amico et al. (2019b)

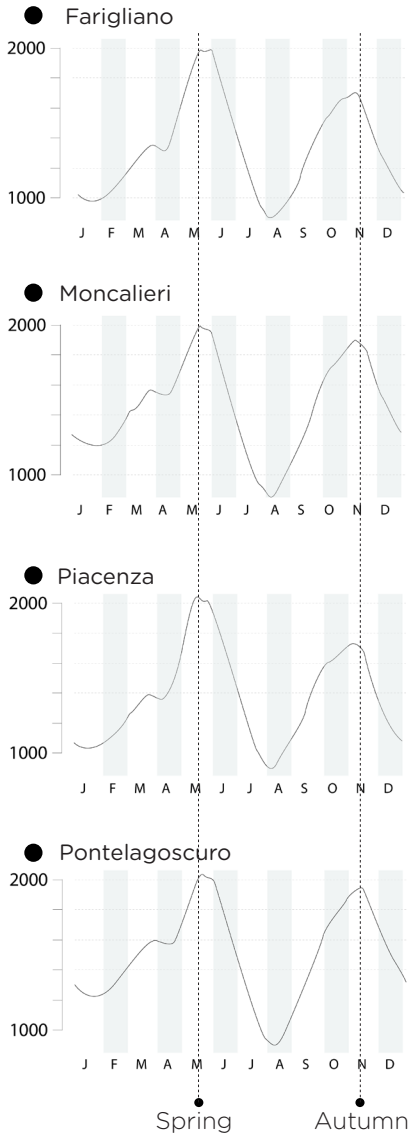
Climate of the Po valley



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

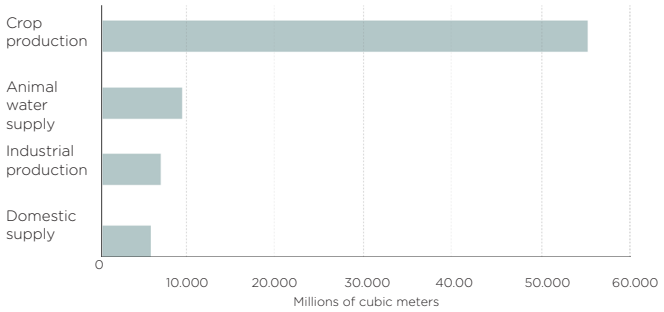


Po region section (North-South)
By author, from data available at NASA, 2023.

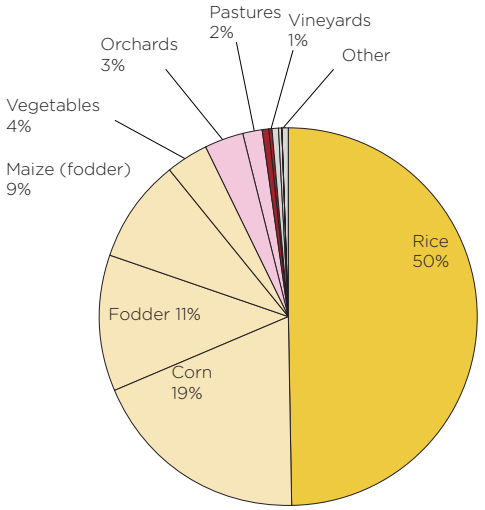


River discharge (m3/s) of the Po river
Source: Montanari, A. (2012) .

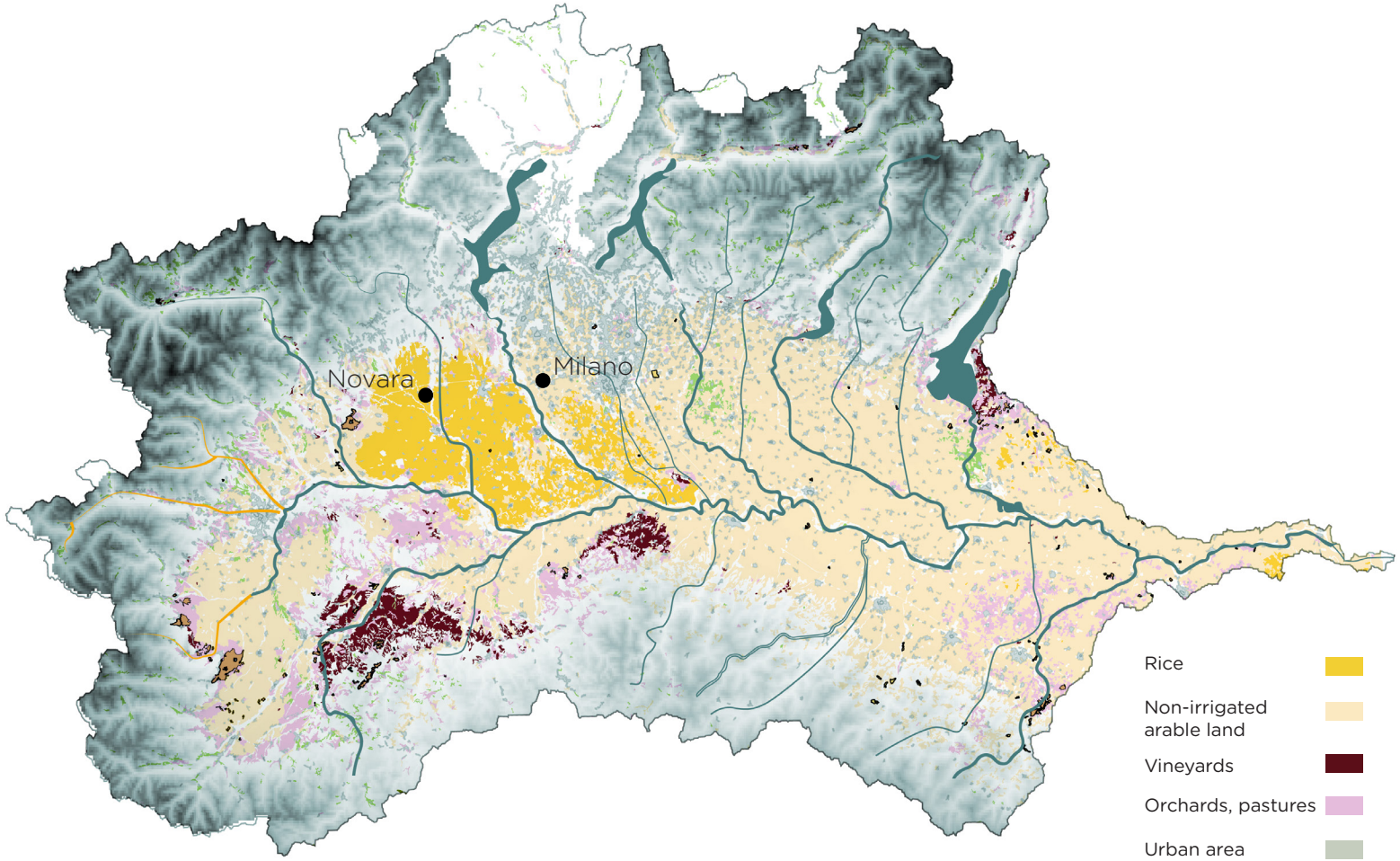
Agriculture’s main artery / crop wateruse



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

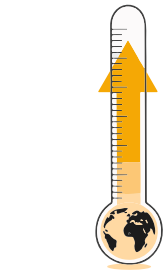


Water footprint of crop production per crop.
By author, based on Mekonnen, M., & Hoekstra, A. Y. (2011b).

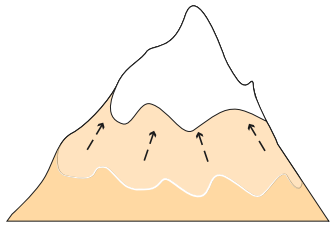


Agricultural landcover of the Po river basin.
By author, from data published by Copernicus & Land Monitoring Service.

Effects of climate change

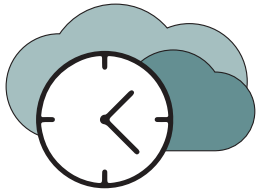


temperature increase



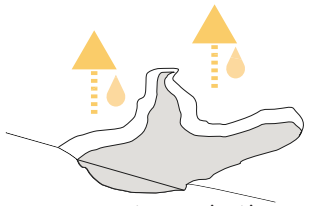
snowline altitude increase

- decreased natural storage capacity
- decreased water table recharge
- lesser amounts of meltwater in spring



precipitation dynamics change

- fewer moments of precipitation
- increased intensity of precipitation, resulting in losing water to the sea



evapotranspiration increase

- reduced availability of surface water sources

water availability in the landscape is decreasing

Loss of nature

Sources:
Phelan (2020); Farr, (2022); Ward (2023)

Problem

Sources:
Photograph by Francesca Volpi (Bertacche, 2022)

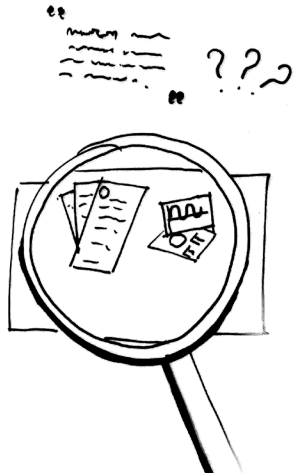
Hypothesis

Sources:
Giorgio (2023)

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?

Methodology

Research question

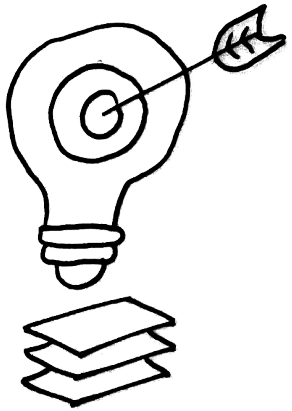


RESEARCH

Design question

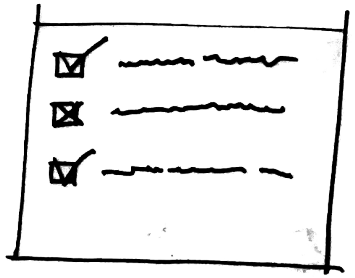
DESIGN STRATEGY

Conclusion



CONCLUSION

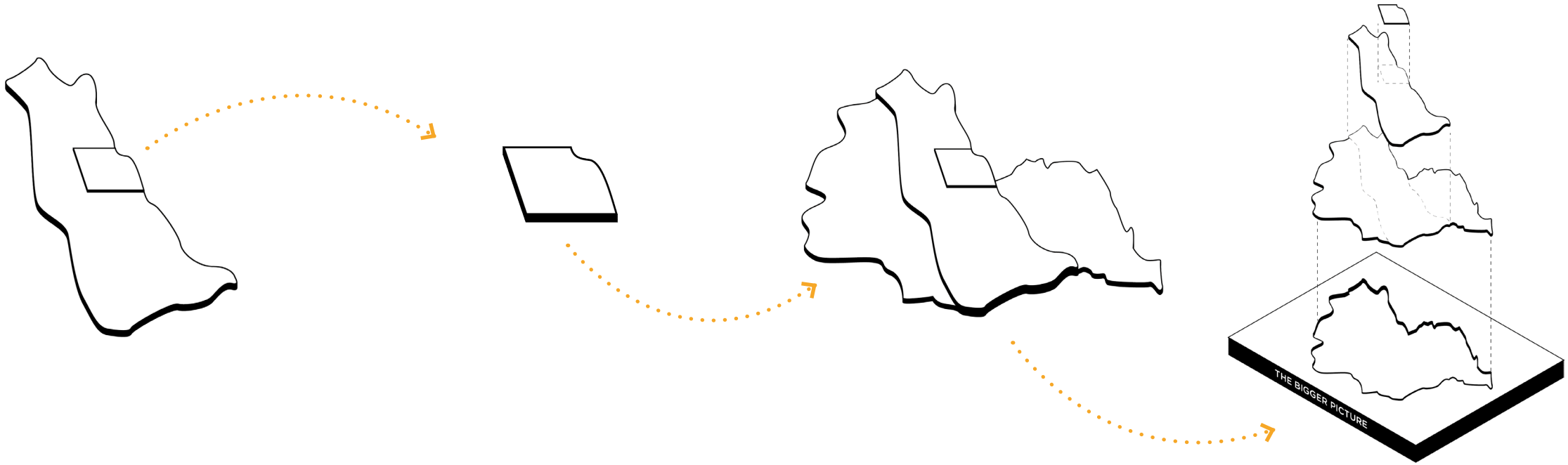
Reflection



REFLECTION

Methods:
paradigm cases

Research question	Design question	Conclusion	Reflection



RESEARCH
SESIA / TICINO / PO

DESIGN STRATEGY
NOVARA

CONCLUSION
RICE PRODUCTION REGION

REFLECTION

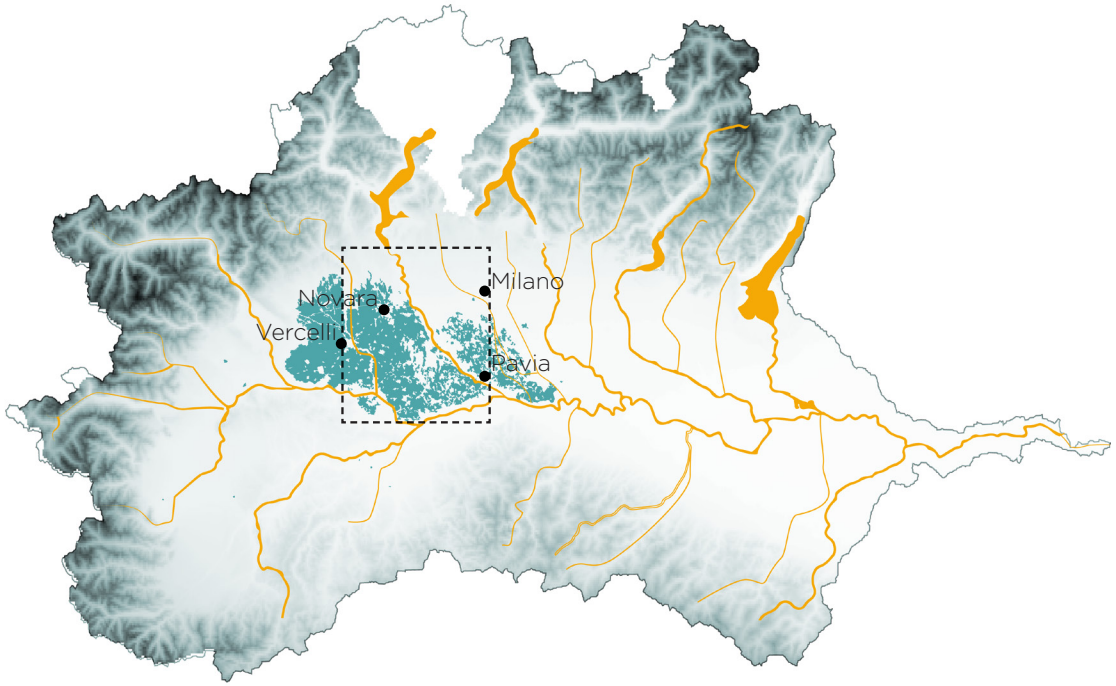
How to provide water security for rice production fitting to evolving water dynamics, while improving the connection between humans and nature in the paradigm case of the Ticino, Sesia and Po river?

Driving forces for landscape transformation

Methods of rice production

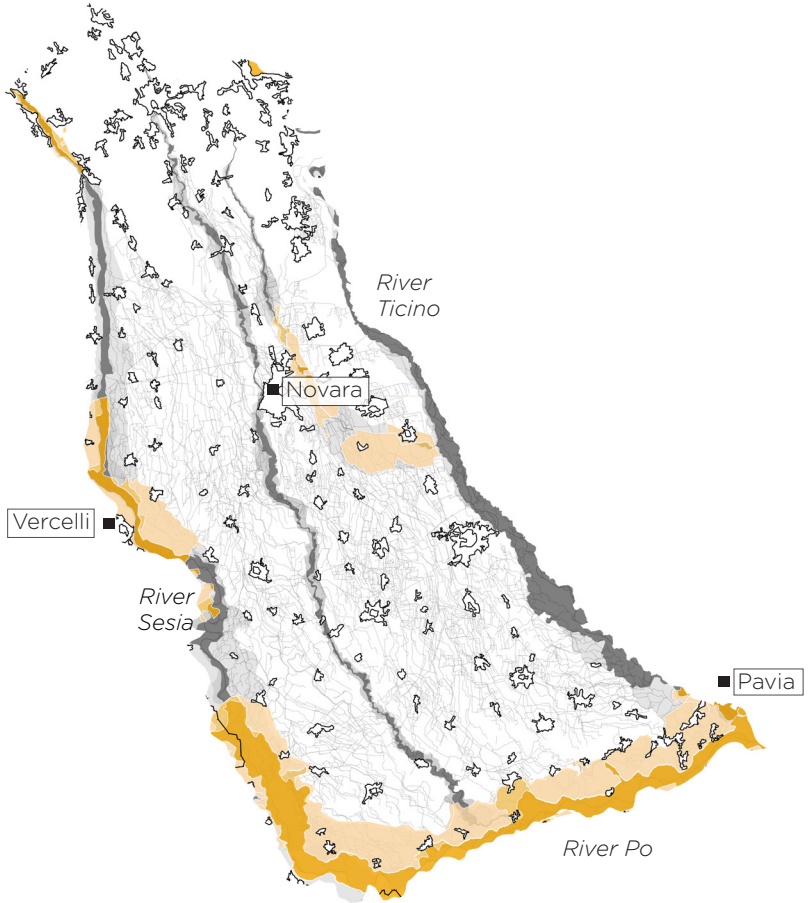
Research to design

Paradigm case



Rice production

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

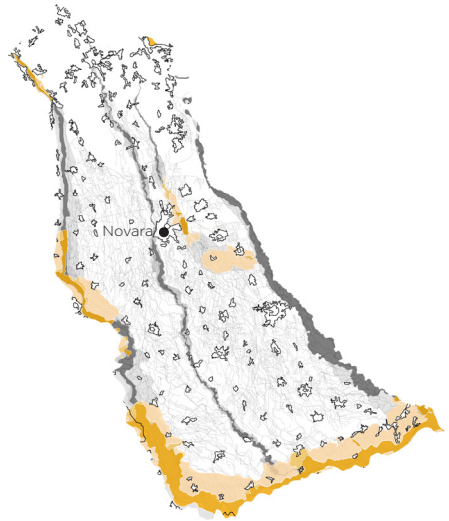


Regional scale of the paradigm case.
By author, from data available at NASA, 2023.

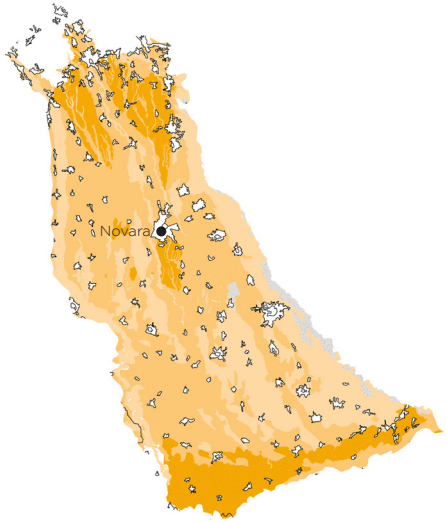
Territorial analysis

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

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

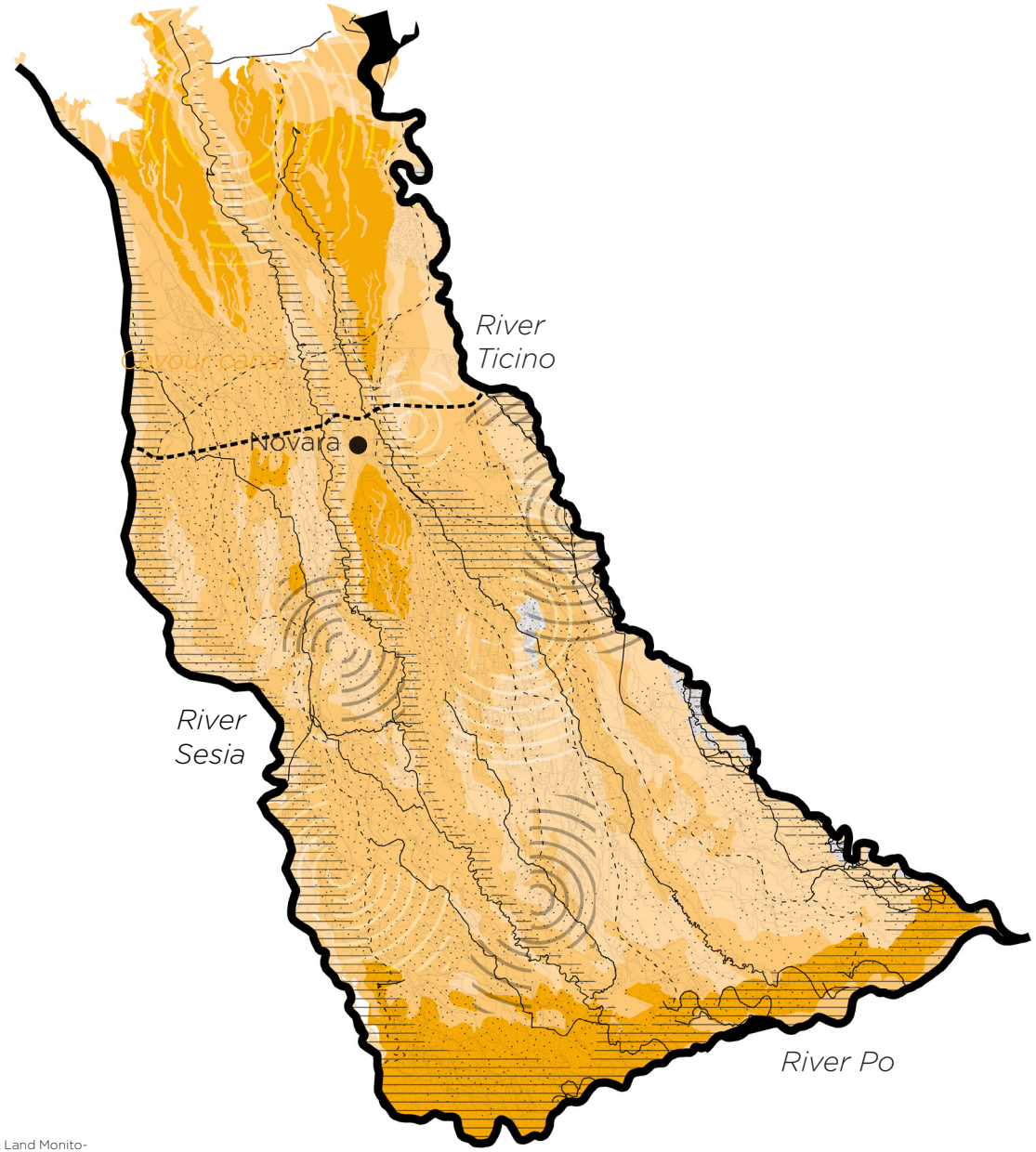


Floodplains & hazard.
By author, from data published by Autorità di Bacino Distrettuale del Fiume Po, 2019.



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

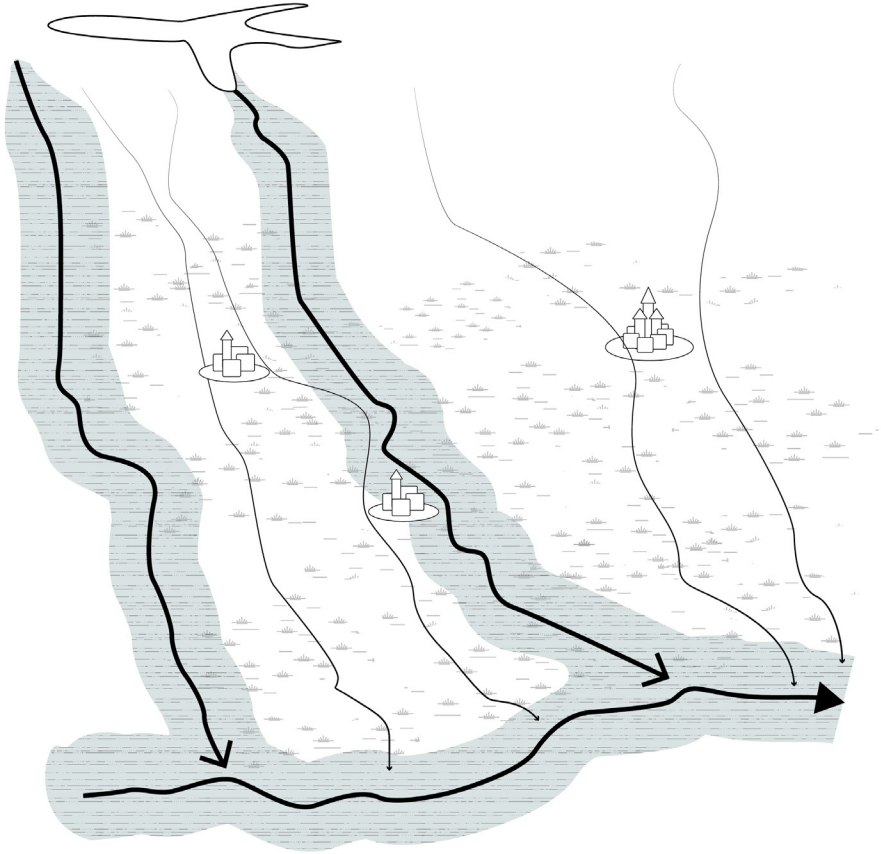
Territorial synthesis



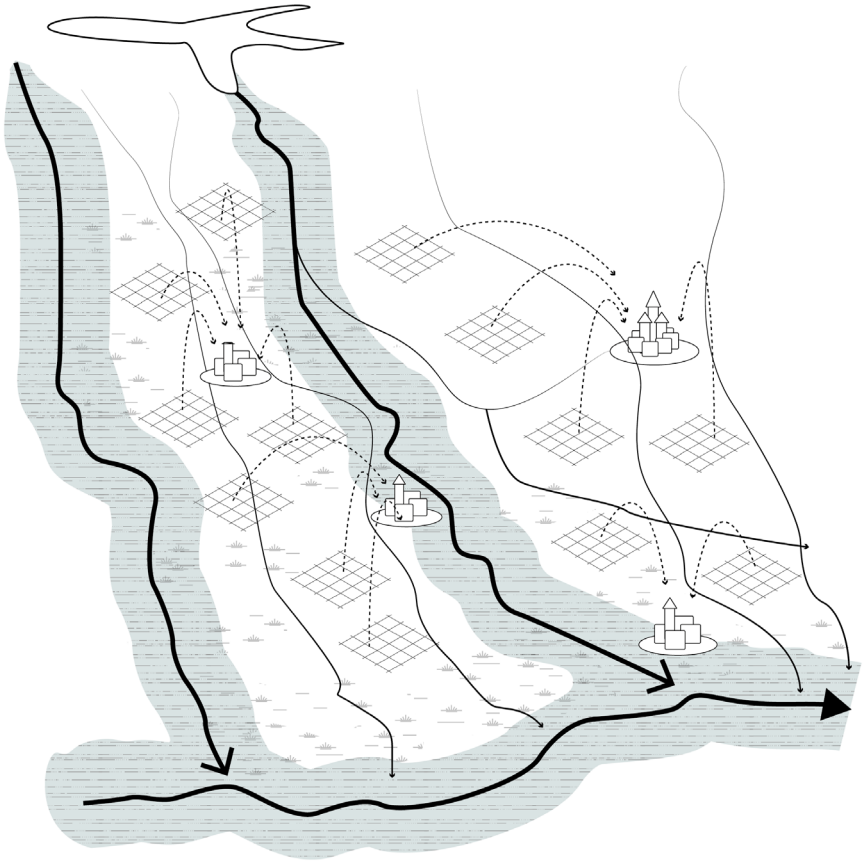
- Clay soil
- Loamy clay soil
- Sandy soil
- Minor rivers and canals
- Floodplain
- Rice
- Primary river
- Secondary river
- Canals
- Drought anomaly
- Soil moisture deficit

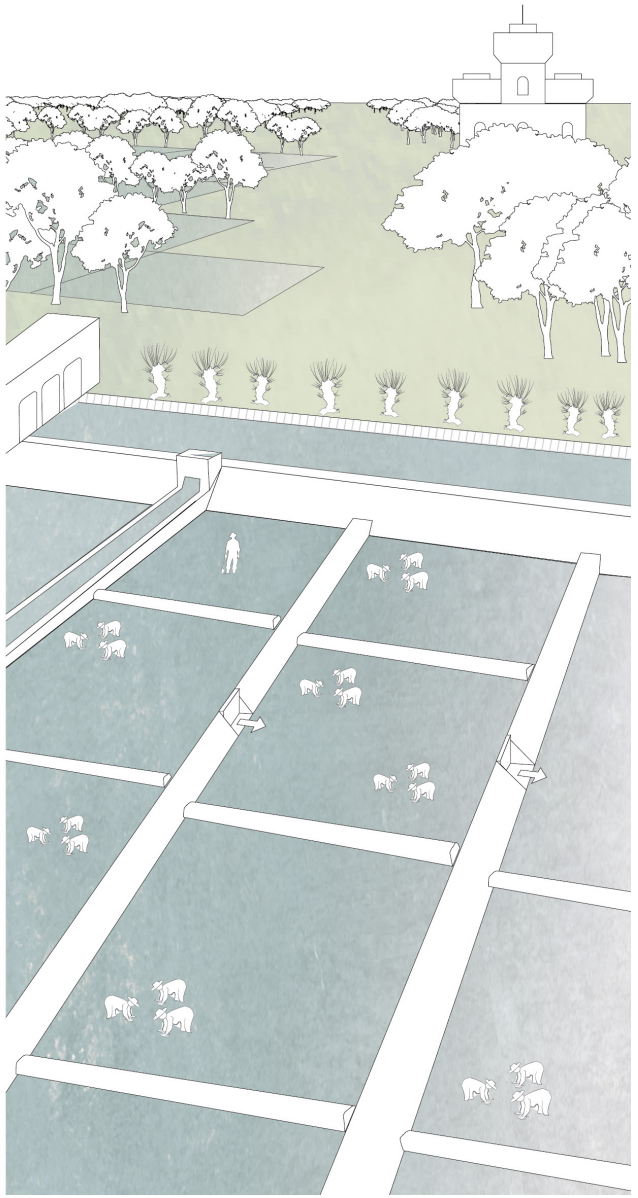
By author, from data published by Autorità di Bacino Distrettuale del Fiume Po, 2019) & Copernicus & Land Monitoring Service, 2023 & Regione Lombardia & ERSAF (2024) & Geoportale Piemonte (2024).

Driving forces for landscape transformation:
establishment

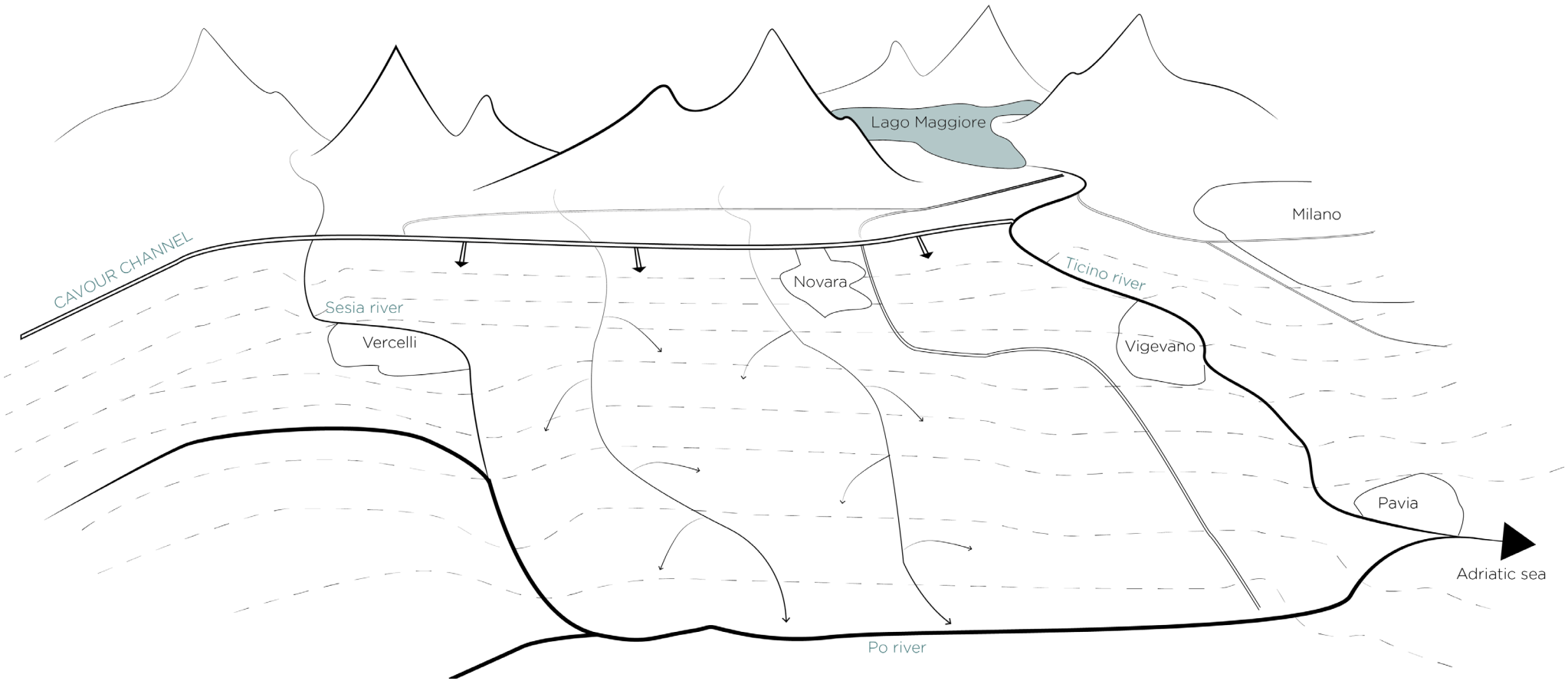


Driving forces for landscape transformation:
refinement

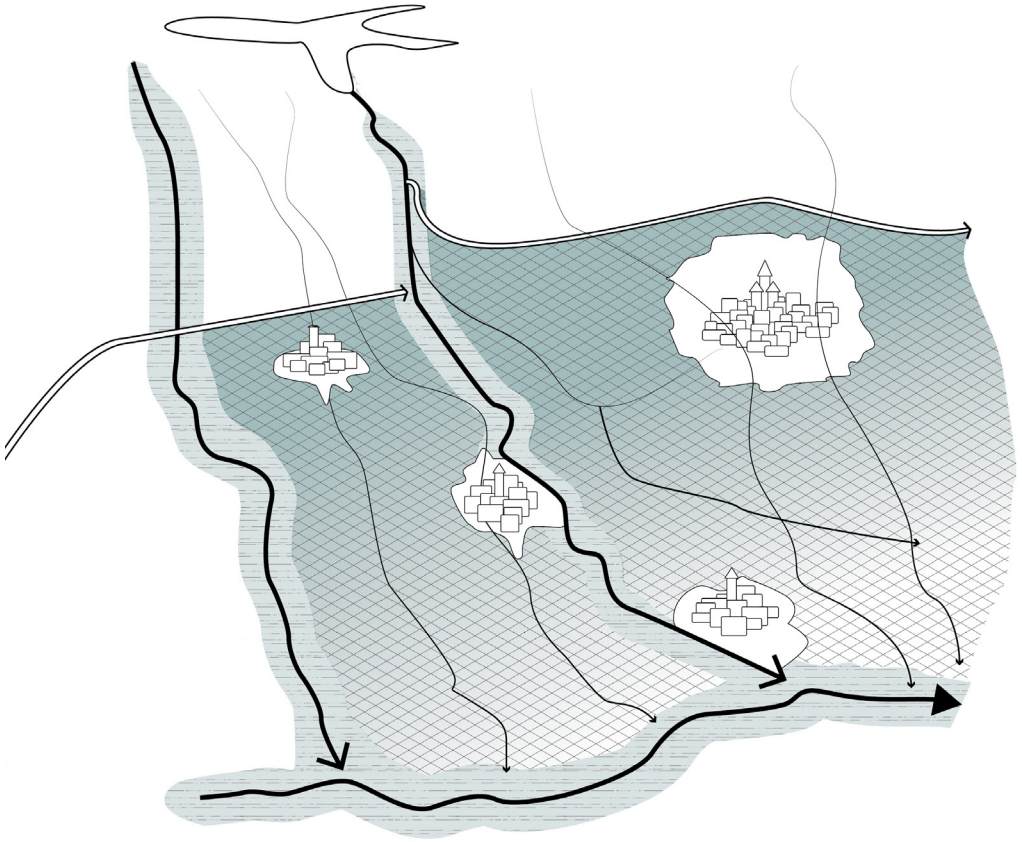


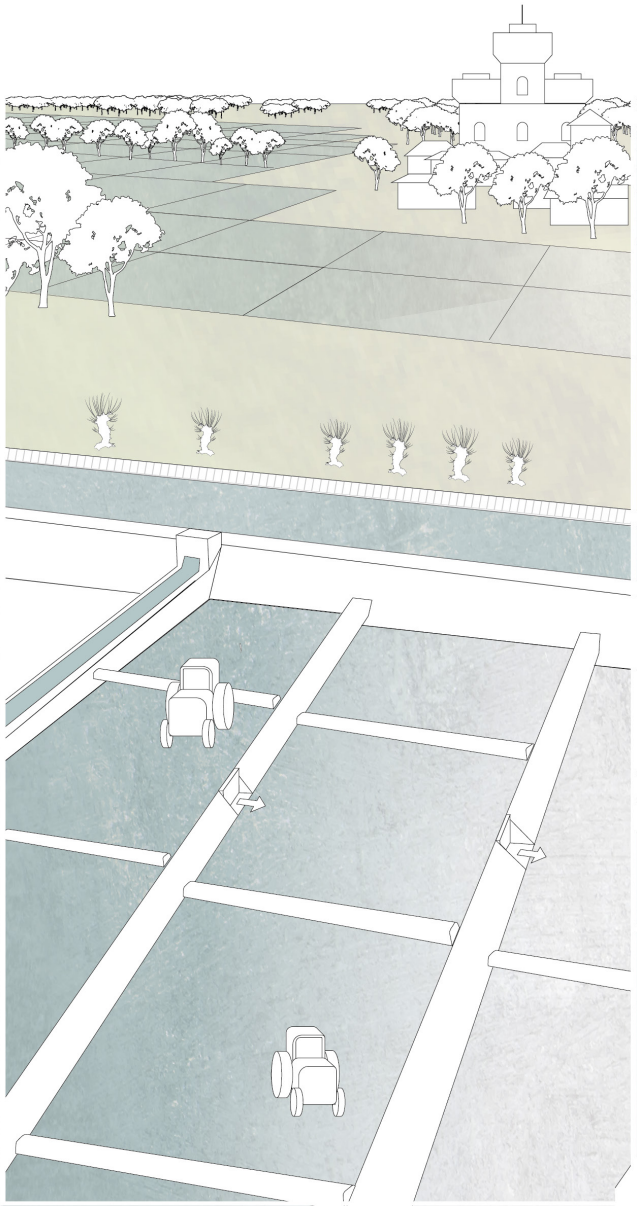


Driving forces for landscape transformation:
history

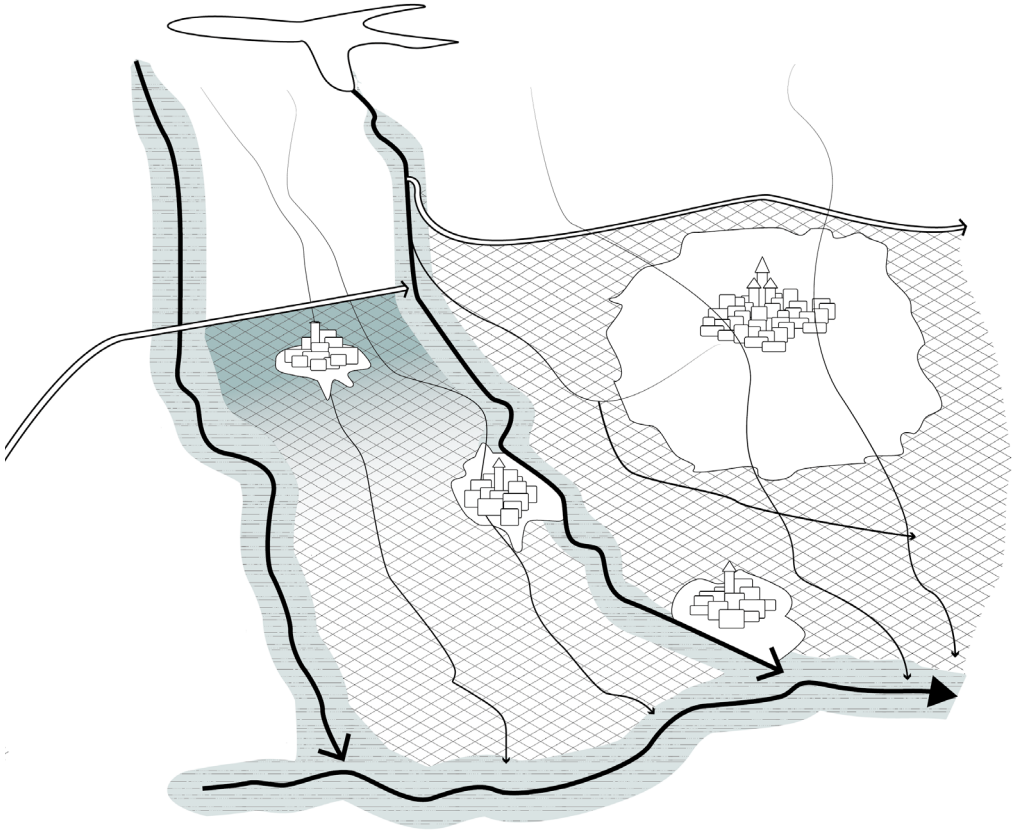


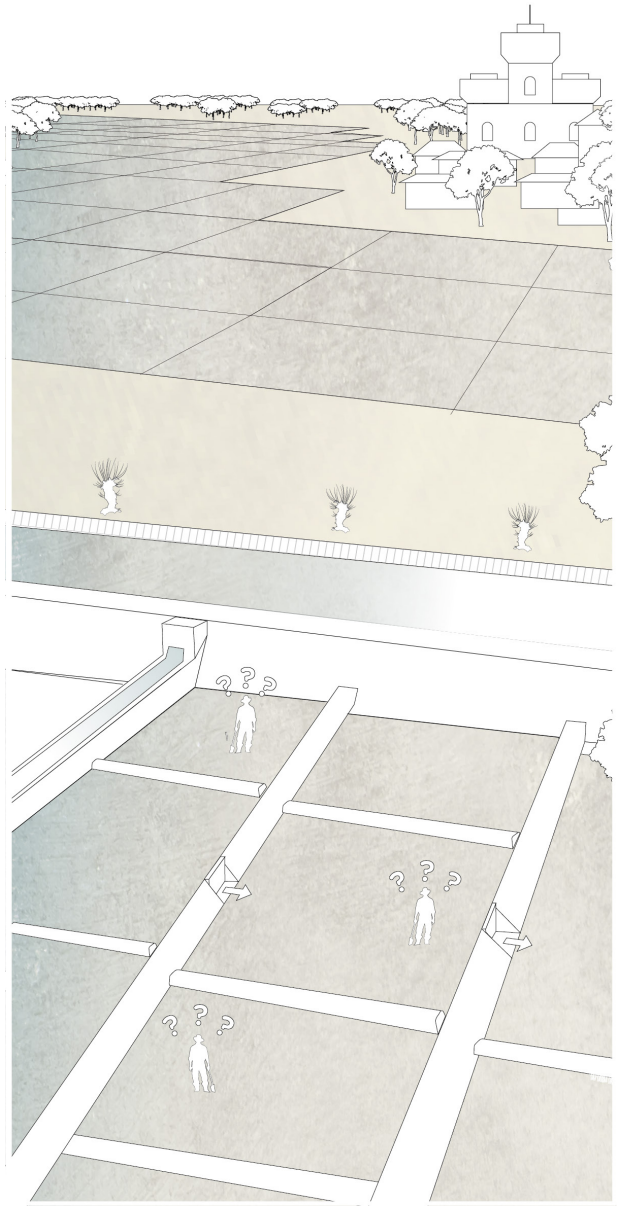
Driving forces for landscape transformation:
industrialisation





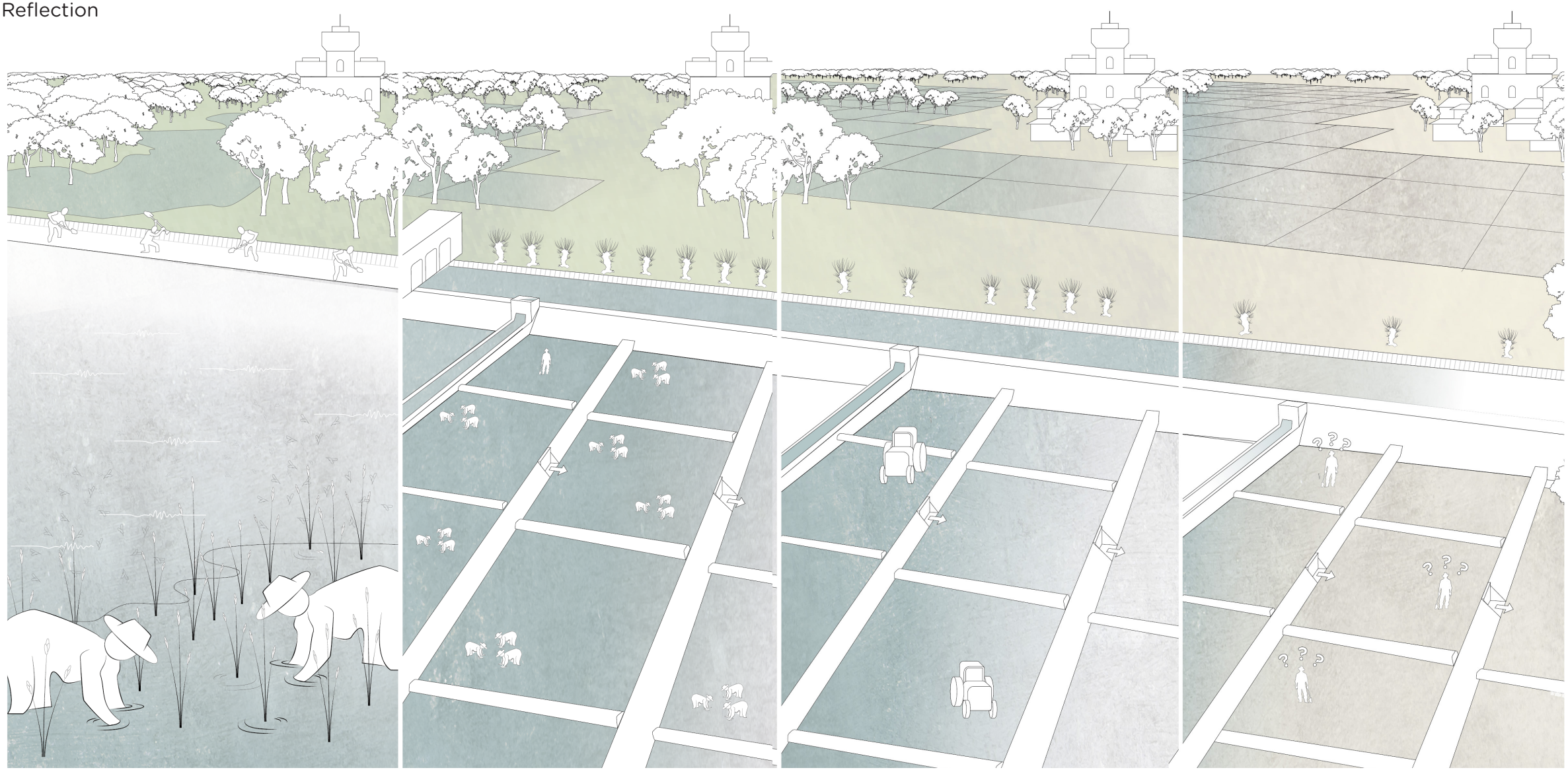
Driving forces for landscape transformation:
contemplation





Driving forces for landscape transformation:

Reflection



1 ESTABLISHMENT

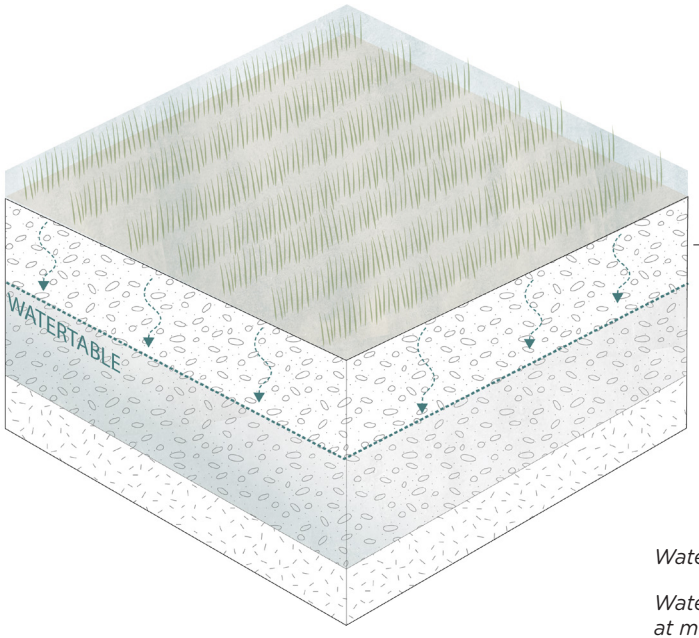
2 REFINEMENT

3 INDUSTRIALISATION

4 CONTEMPLATION

Methods of production

Traditional Practice



Clay soil retains water

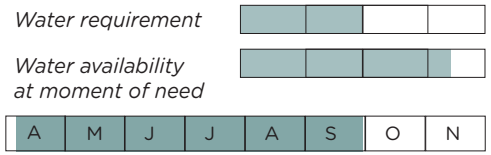
Water necessary until saturation

\+ *use water when excessive*

\+ *ecosystem services (habitat)*

\+ *water table recharge*

\- *more labour intensive*

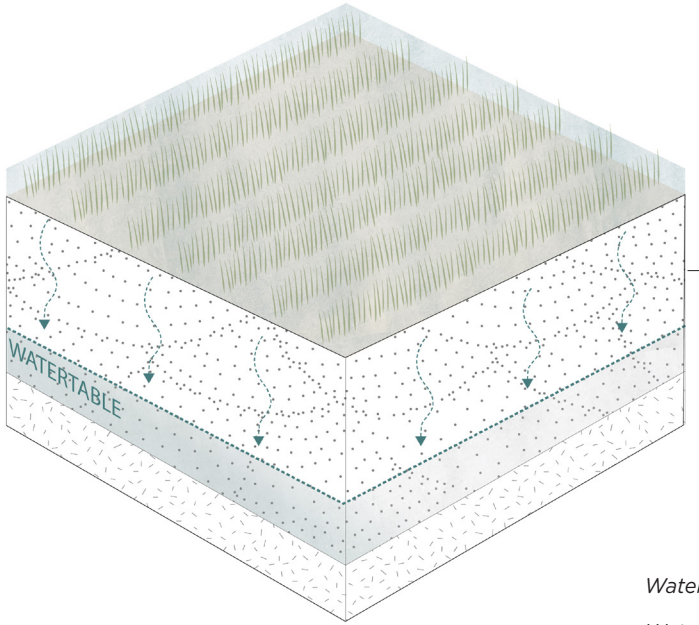


Sand

Impermeable layer

Clay / loam

Dry Seeding Practice



Sandy soil allows for quick infiltration

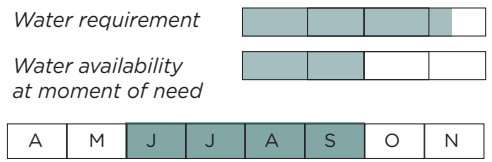
Water necessary until saturation

\- *demands water when conflictive*

\- *little ecosystem-services (habitat)*

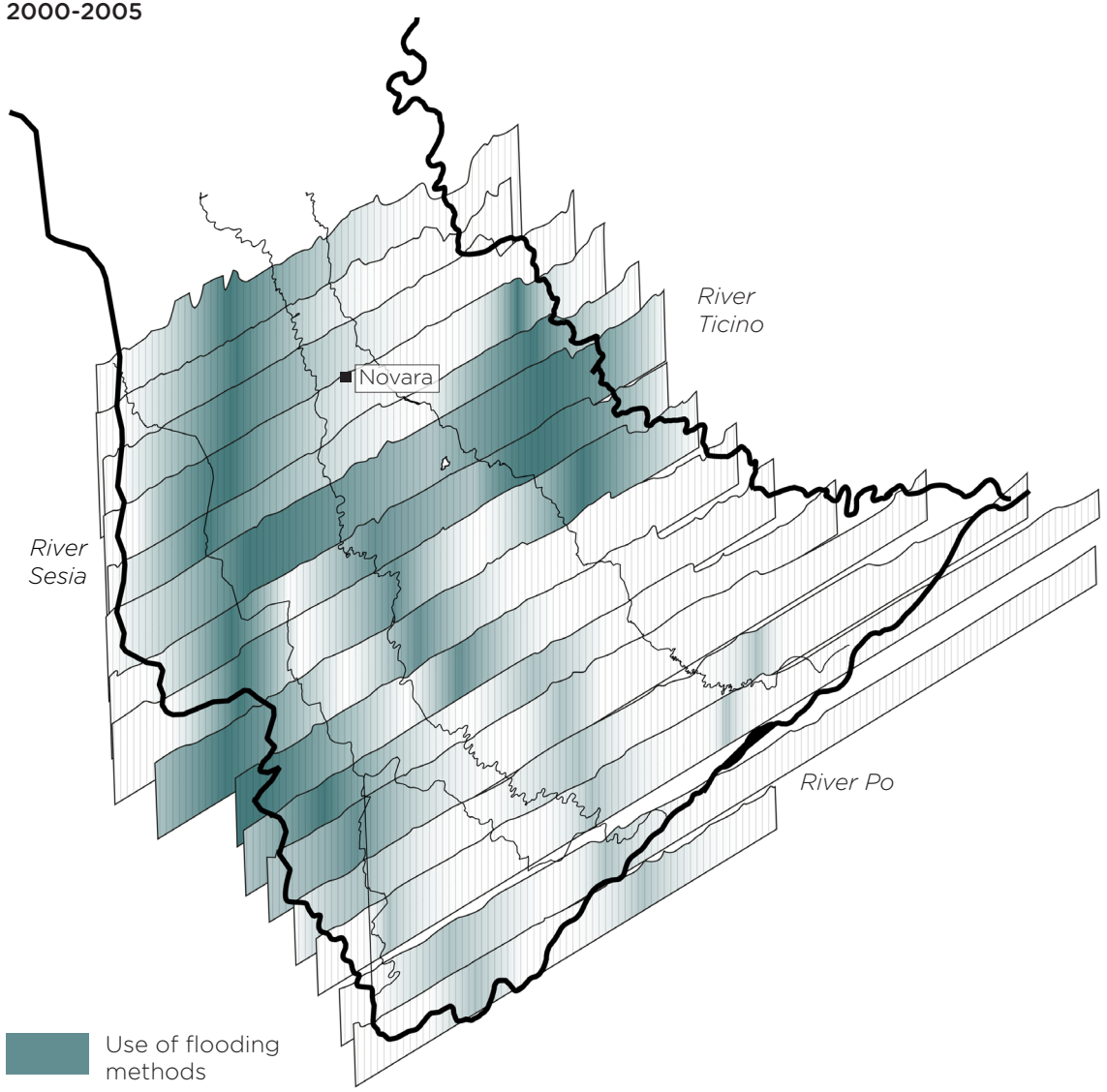
\- *delayed water table recharge*

\+ *less labour intensive*

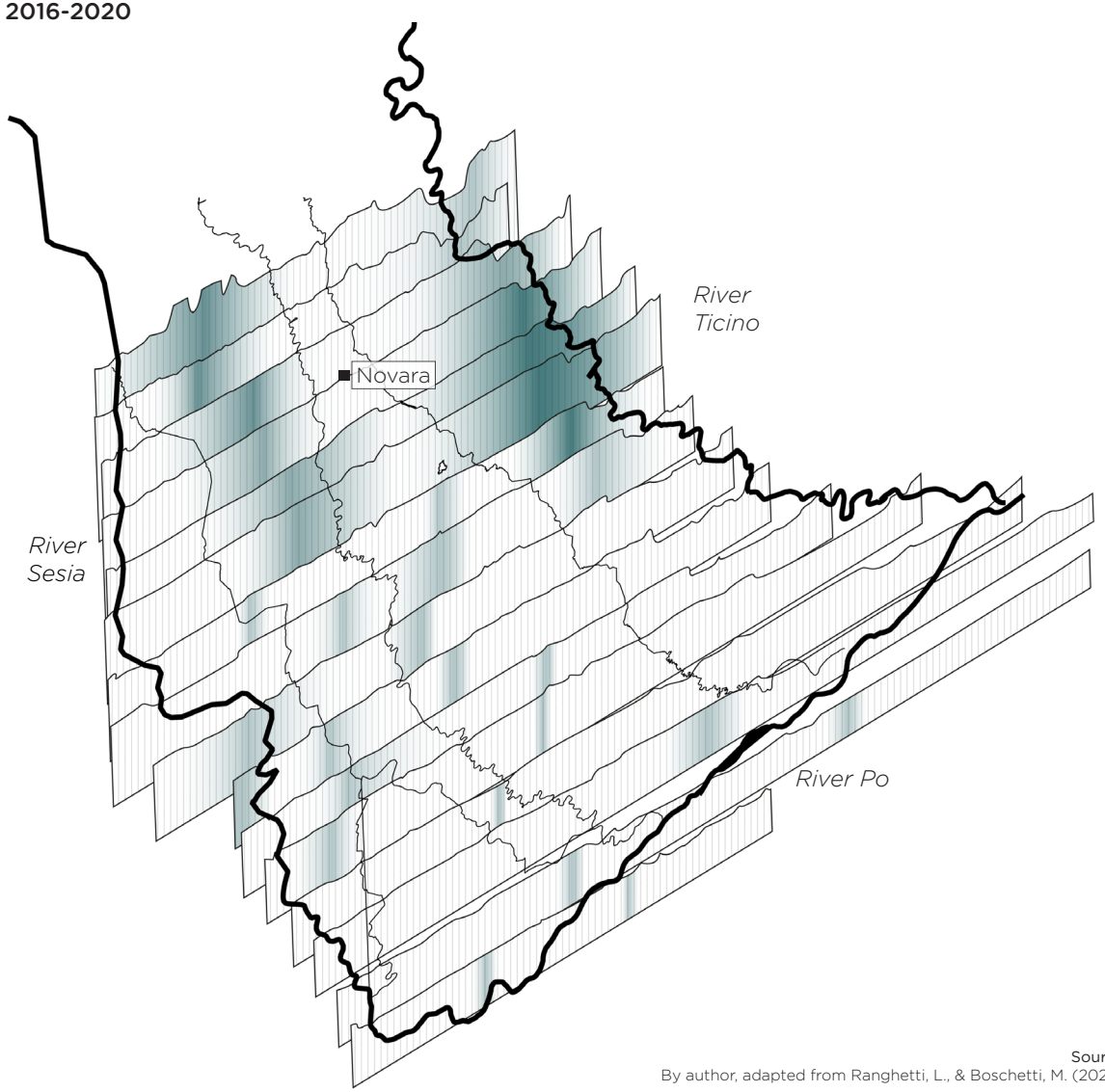


Territorial effects:
regional

2000-2005



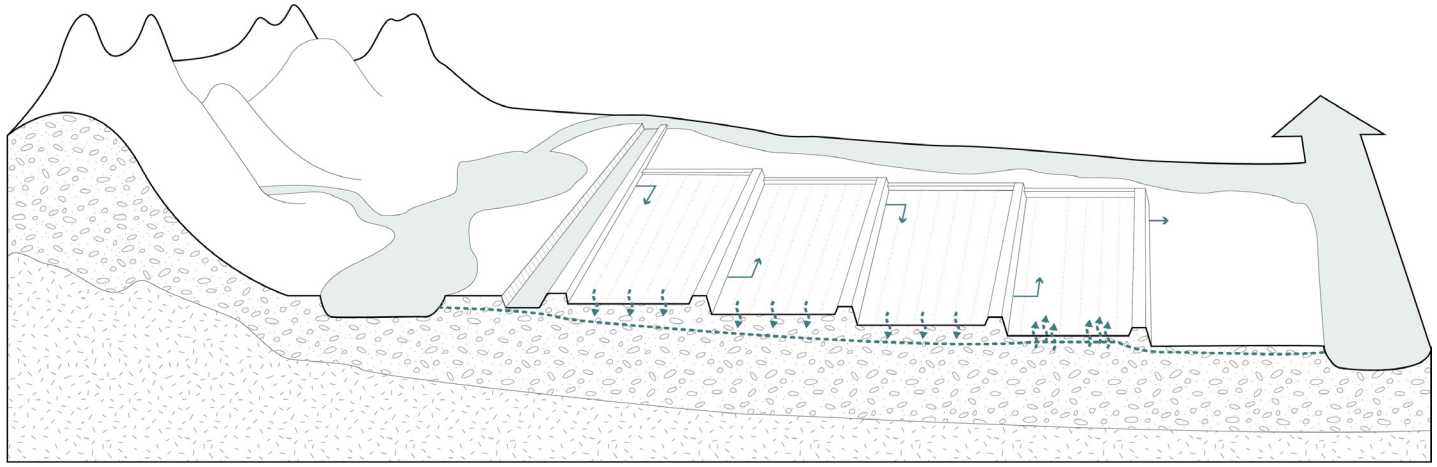
2016-2020

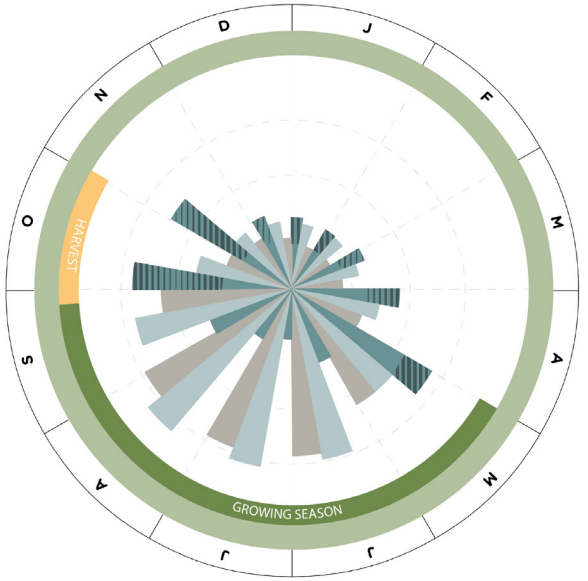


Source:
By author, adapted from Ranghetti, L., & Boschetti, M. (2021c)

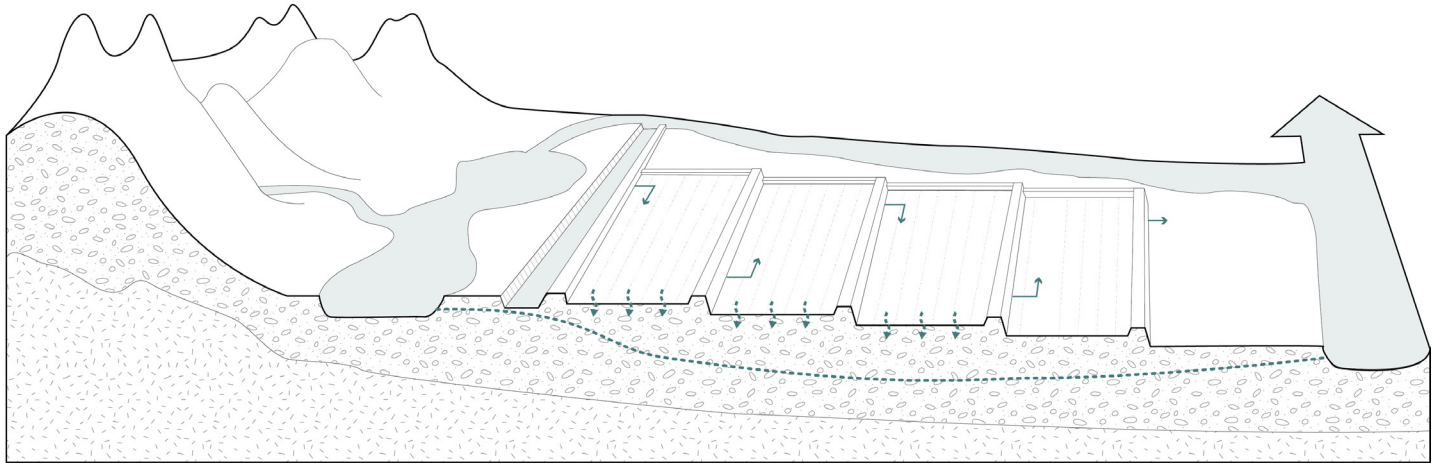
Territorial effects:
in section

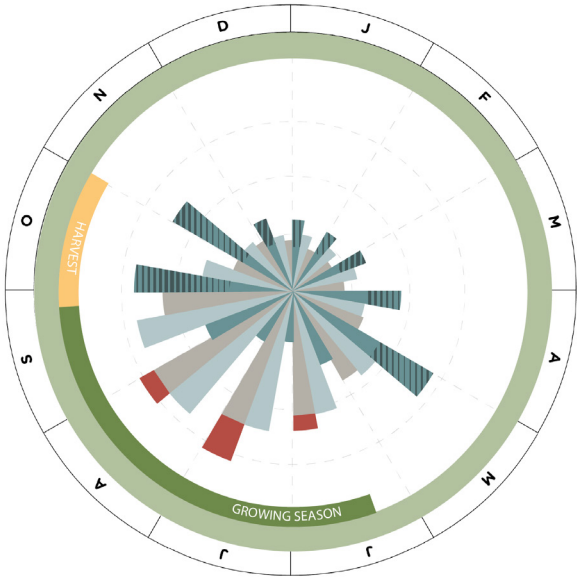
Traditional practice





Dry-seeding practice





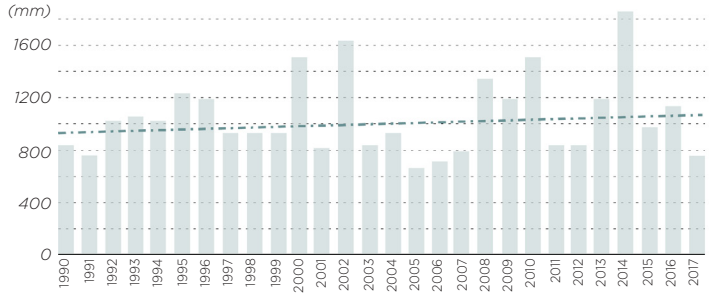
Watercycle

- *Excess (mm)*
- *Shortage (mm)*
- *Harvest*
- *Growing Season*
- *Precipitation (mm)*
- *Watertable (m)*
- *Water demand (mm)*

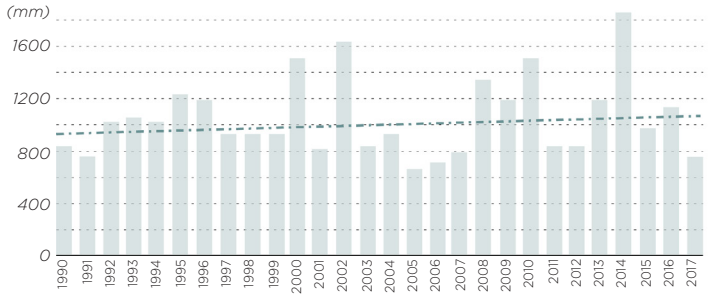
Climate change

Busto Arsizio (upper basin).

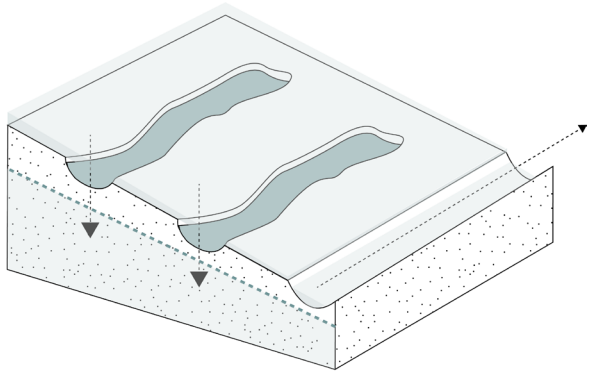
1990-1990: *987mm*
2000-2009: *1034 mm*
2010-2017: *1136mm*



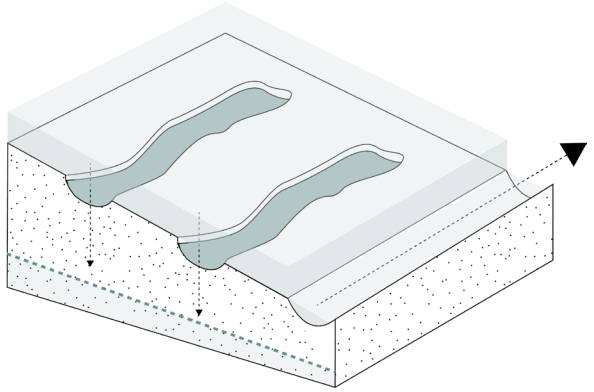
Castello D'Agogna (lower basin).



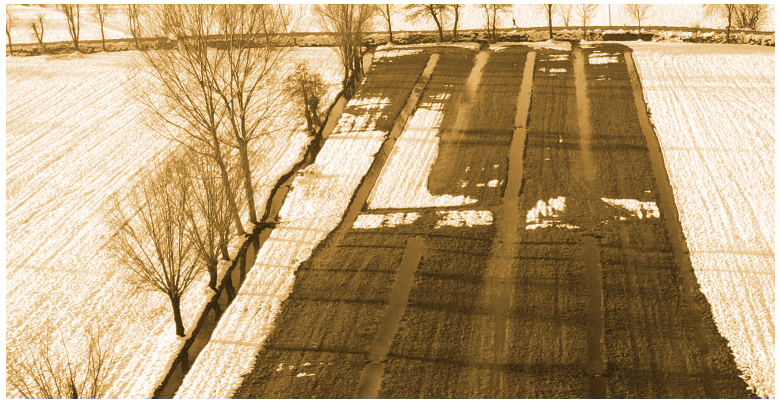
Increasinig precipitation over time, both lower and higher in the basin.
Source: By author, adapted from ARPA Lombardia in Bove & Ente Nazionale Risi (2021).



Runoff during regular precipitation



Runoff during intense precipitation

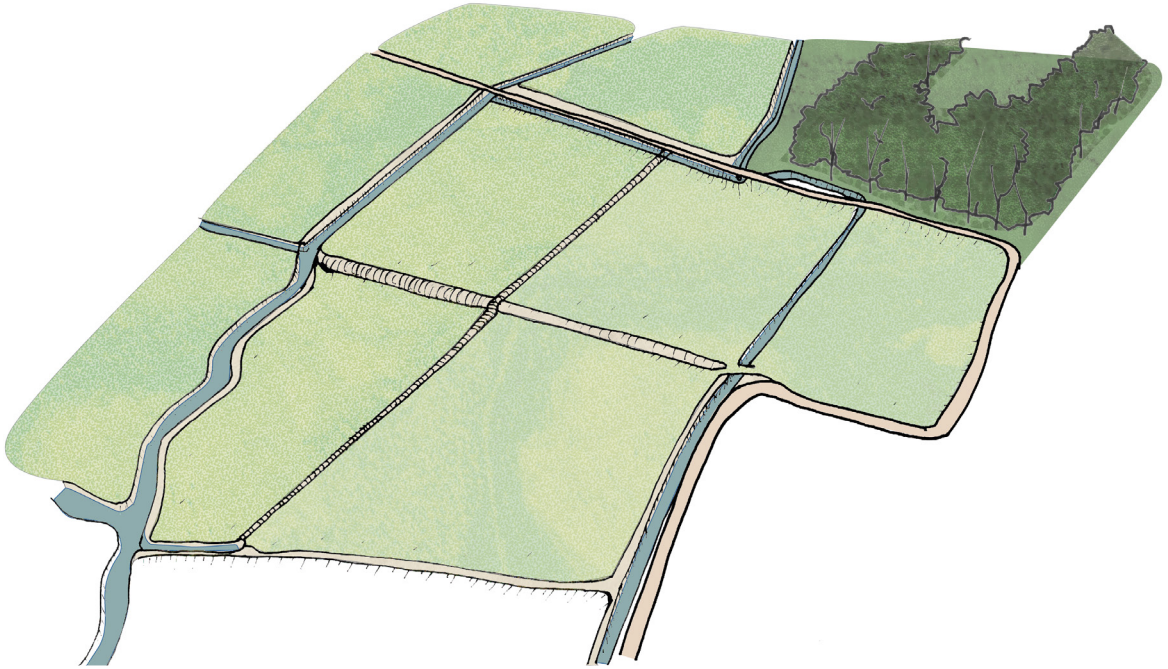


Water meadows (marcita)
Source: Parco Ticino et al., 2024

Circulating water in rice fields during winter
Source: Ristec, 2018

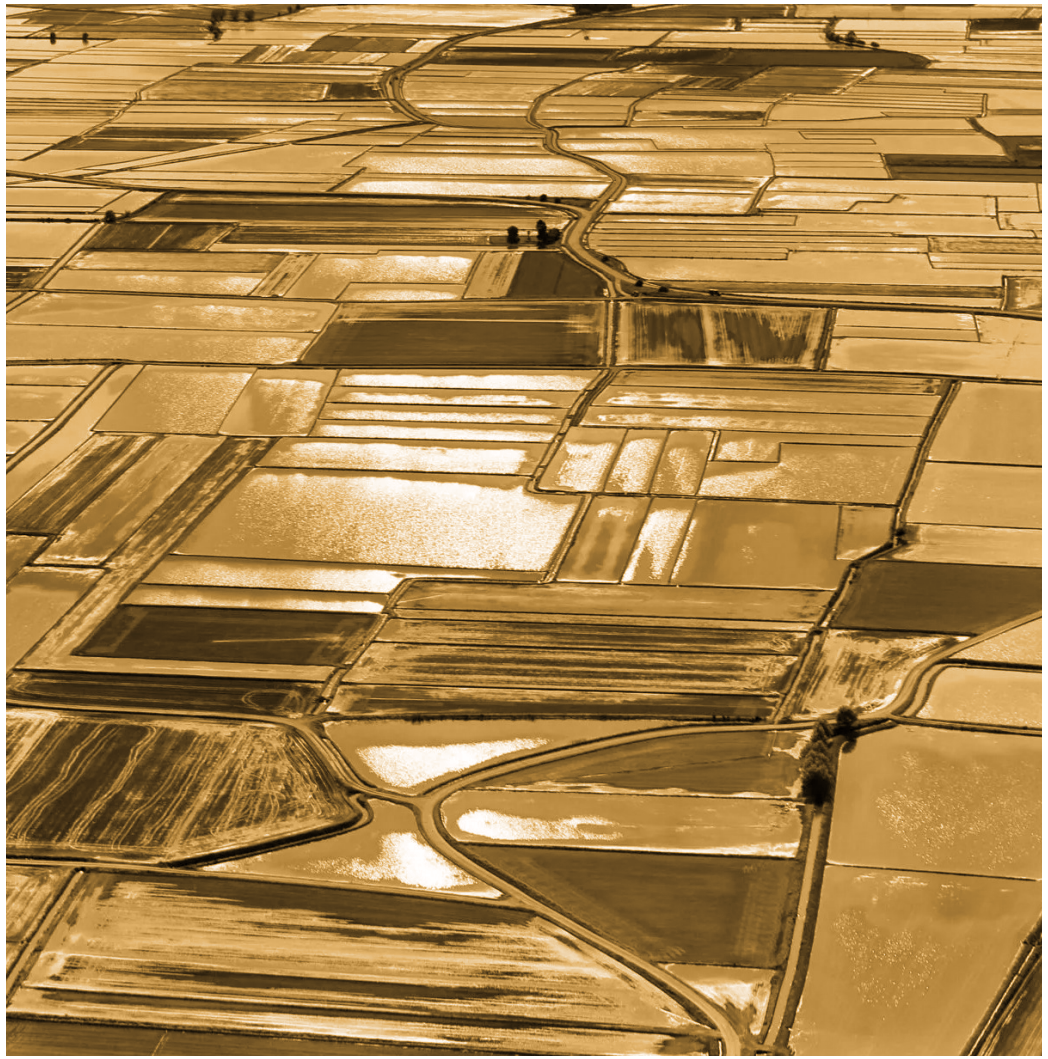
Landscape values & loss of habitat

Traditional landscape elements in rice production



Their disappearance over the years

Landscape transition



“Checkered sea”

“Landscape of dust”

Source:
Giorgio (2023); Risoitaliano (2023)

Research question

How to provide water security for rice production fitting to evolving water dynamics while improving the relationship between humans and nature?

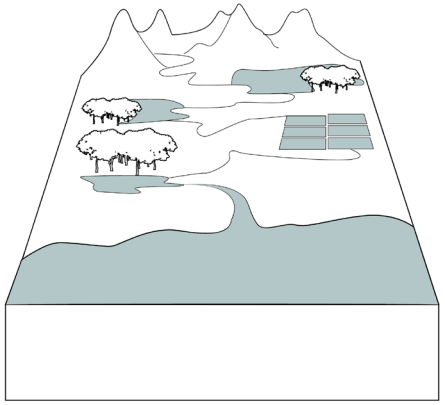
In favor of **economic revenue**, changing the methods of production and **disappearance** of their characteristic **landscape elements** have **disrupted** the **balance** that is fundamental for achieving the right **agronomic conditions** and providing **ecosystem services** for both rice production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

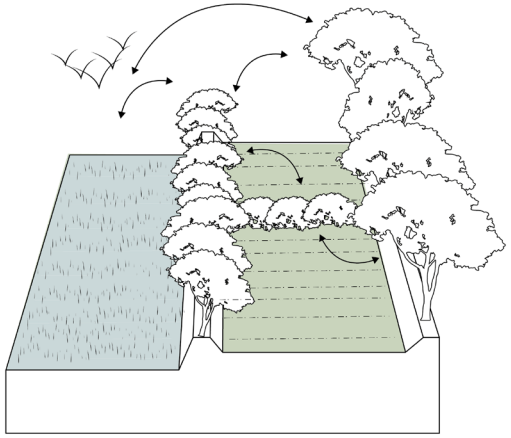
Conclusion

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.

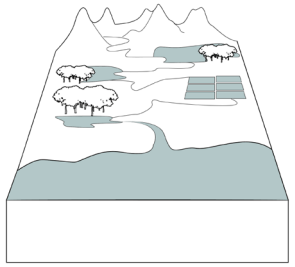
Design goals

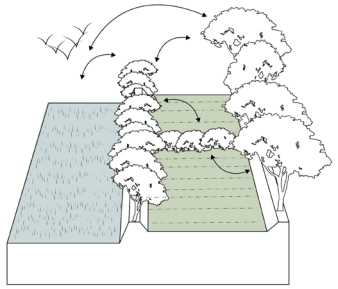
Re-establishing a balanced water cycle, by **retaining water in the landscape** as long as possible while **providing habitat** by agriculture.





Design strategies
design question





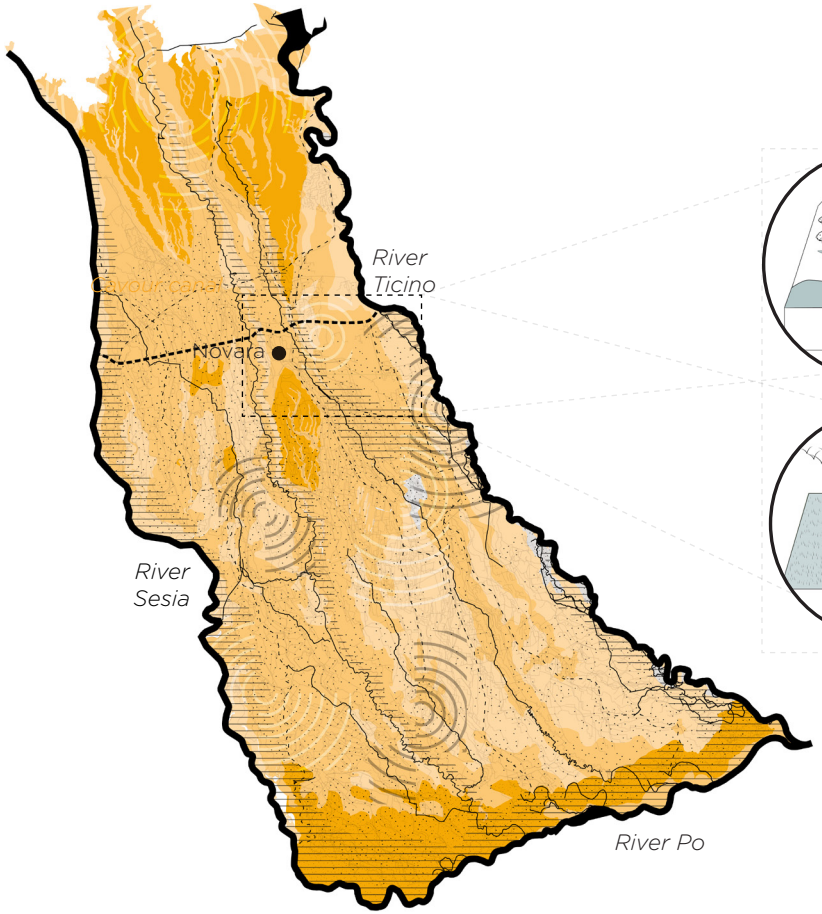
How can design reinforce habitat provision in rice production, enhance water security and improve the connection between humans and nature in the urban rural context of Novara?

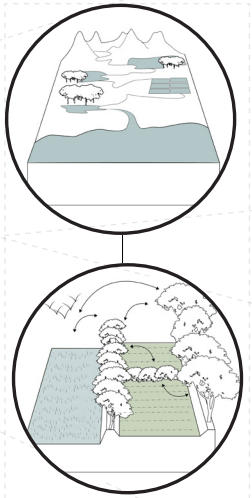
Strategy context

Vision for the urban-rural interface

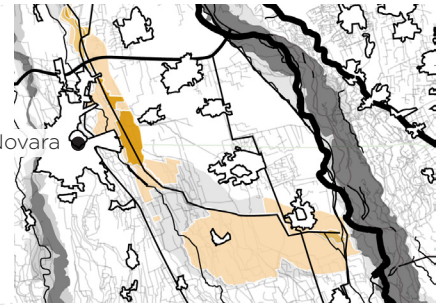
Strategy context:
Motivation & Goals

Location of the design strategy



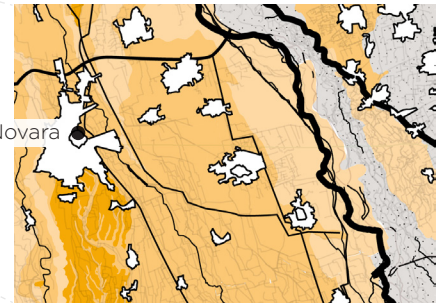


Themes & goals



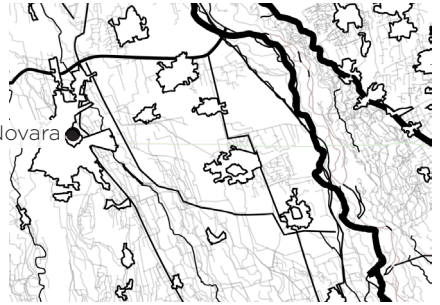
1 Floodplain

- store inundation water



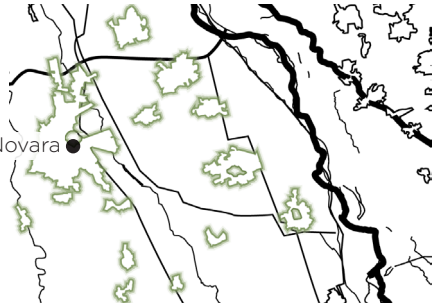
2 Soil

- postpone or utilise natural drainage
- increase drainage capacity



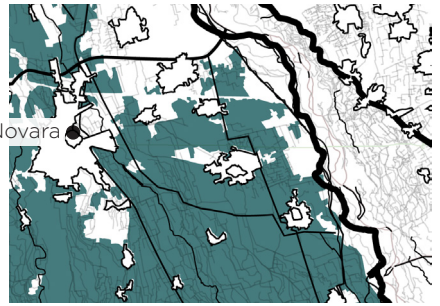
3 Waterstructure

- reduce evaporation
- use water for habitat



4 City borders

- provide buffer zone
- reduce polluted runoff



5 Rice

- use traditional flooding
- increase ecological habitat

Strategy context:
Approach

Canals as ecological corridors

Urban riparian buffer

Habitat inclusive rice production

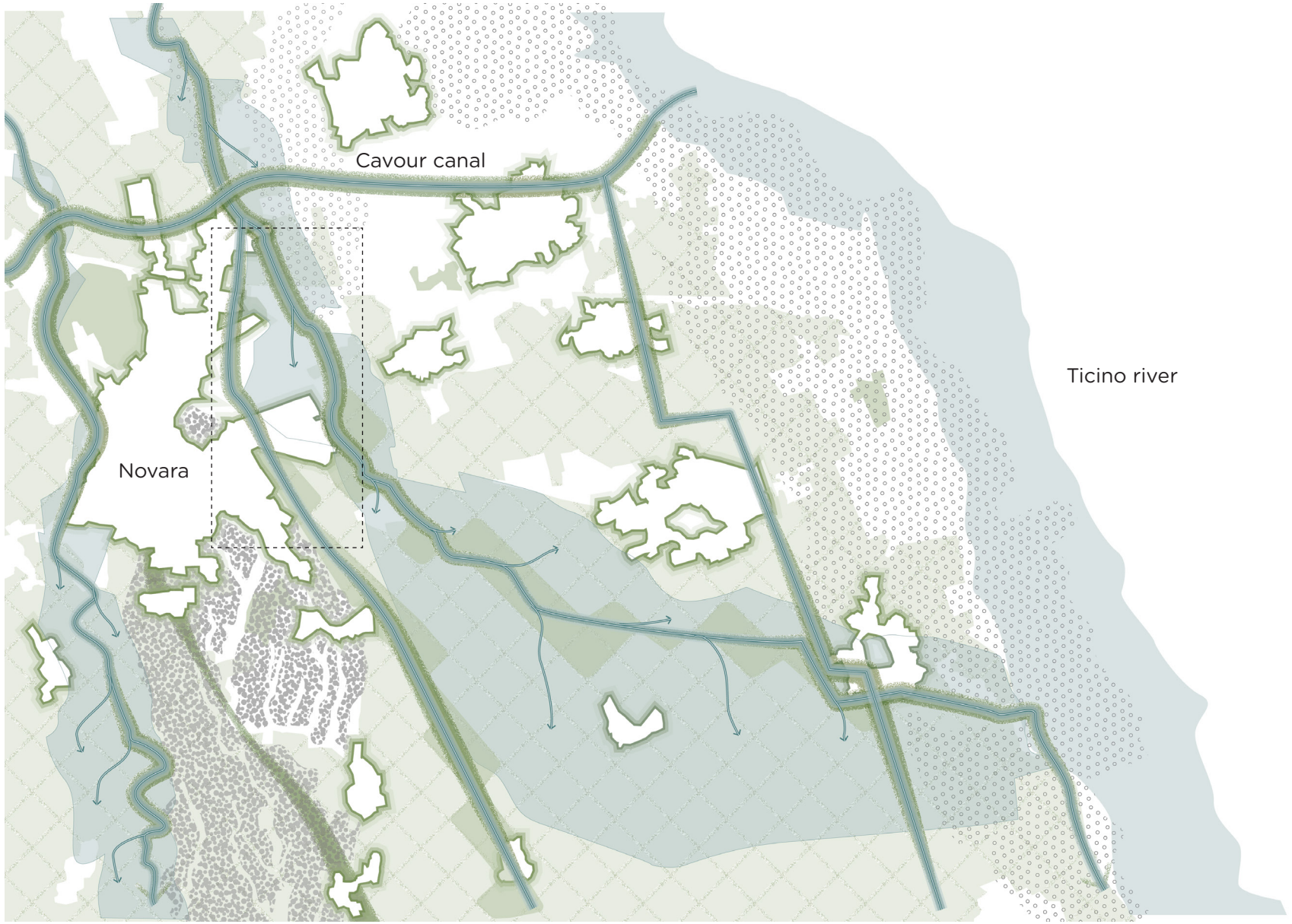
Floodplain inundation for infiltration

Adjacent riverscape as wetlands

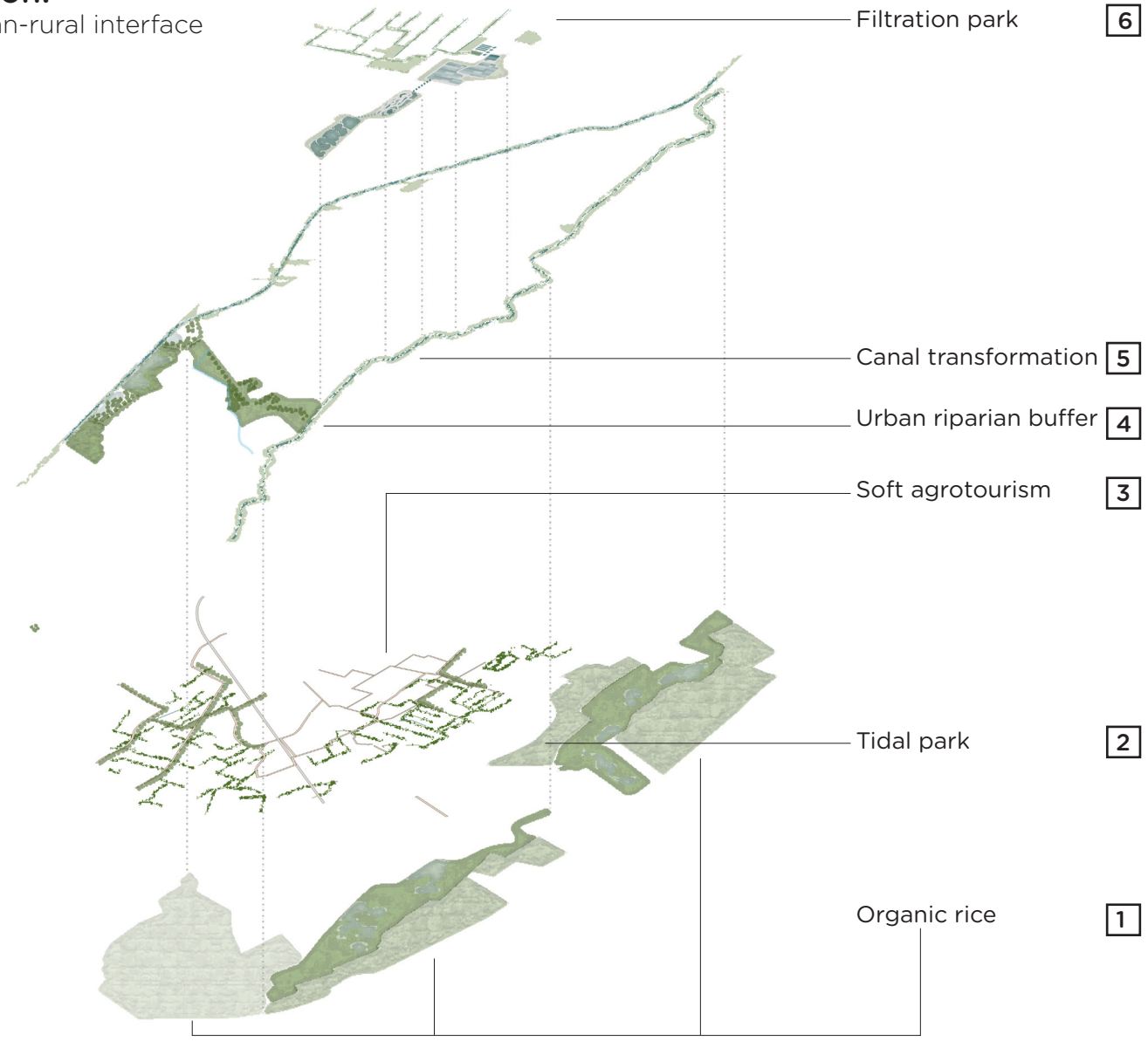
Hard clay soil with increased drainage

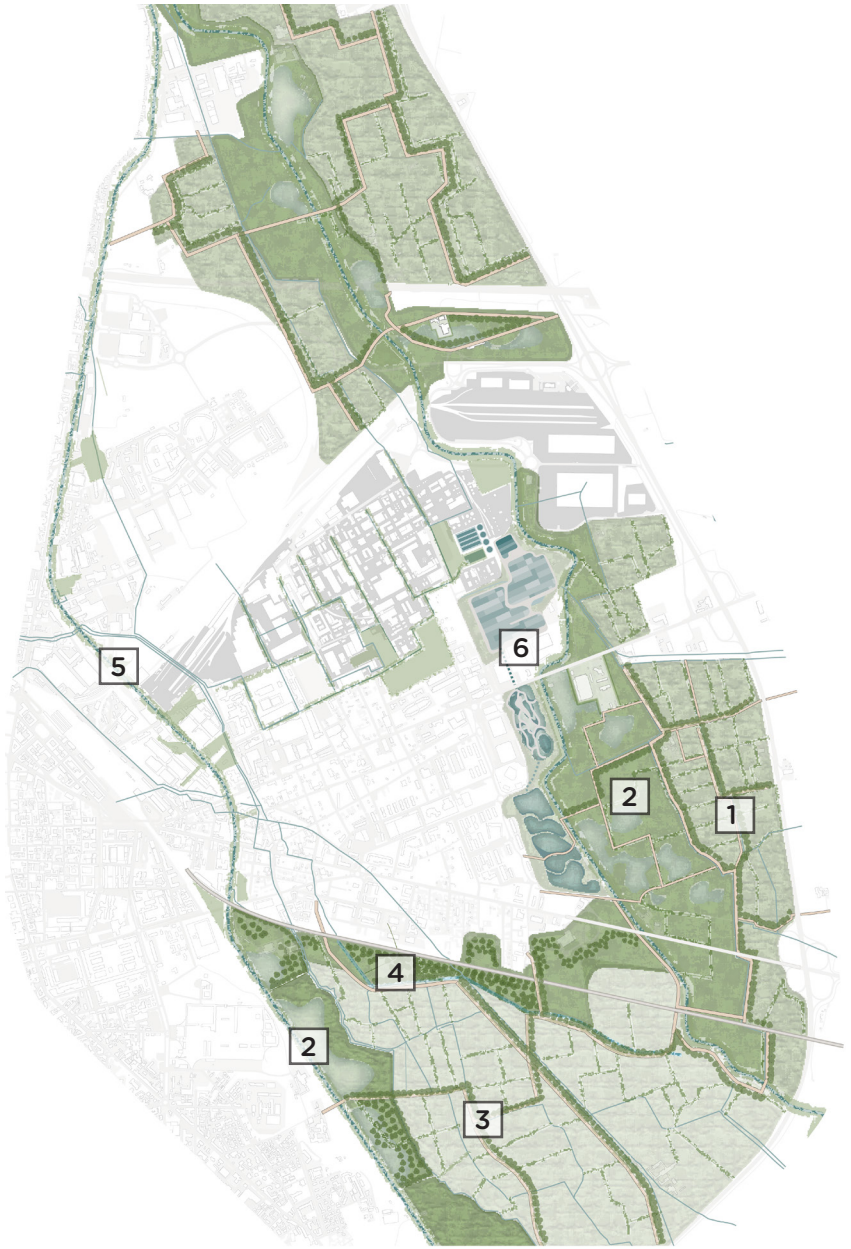
Postponed natural drainage on sandy soil

Vision: urban-rural interface



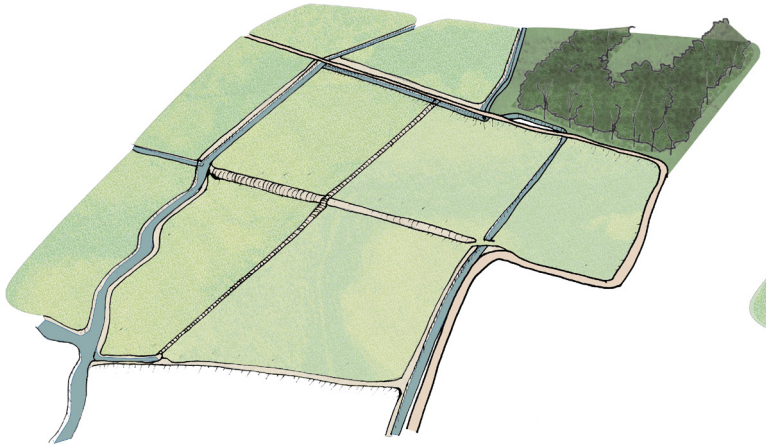
Vision:
Urban-rural interface



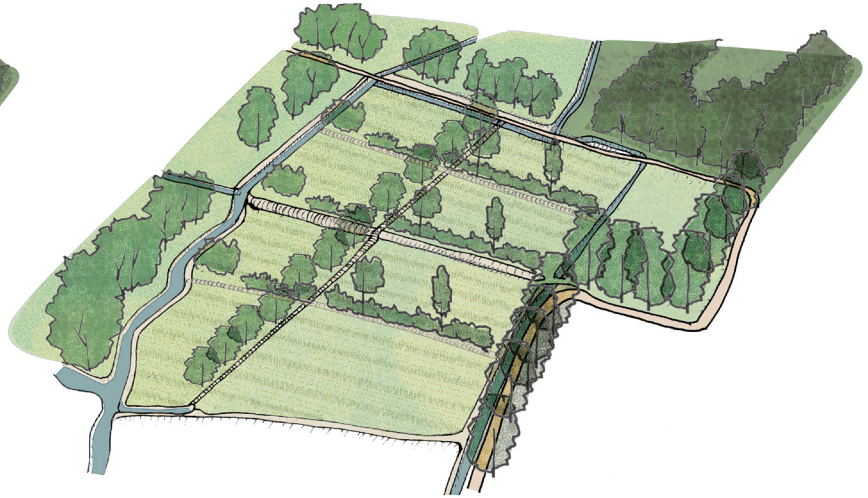


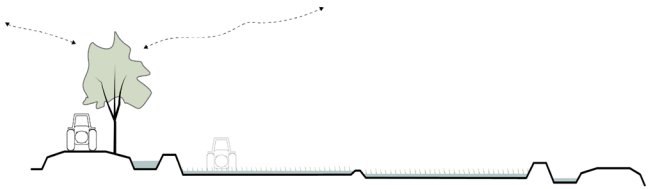
Interventions:
Organic rice

Rice production currently

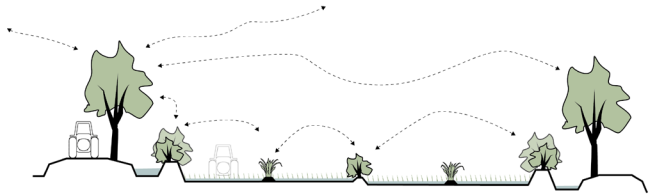


Adoption of organic rice





Rice production currently: section

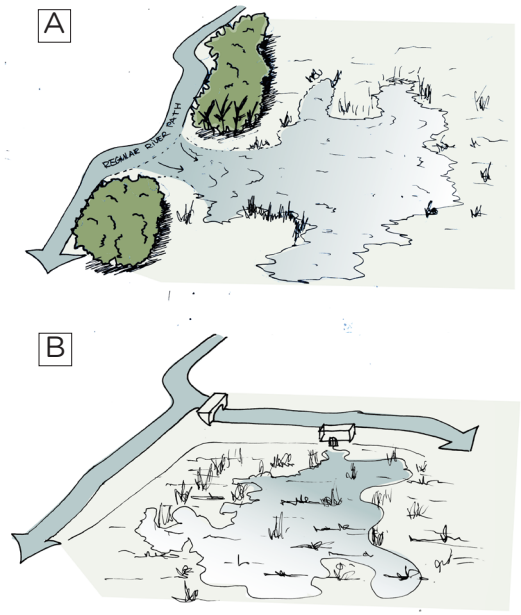


Adoption of organic rice: section

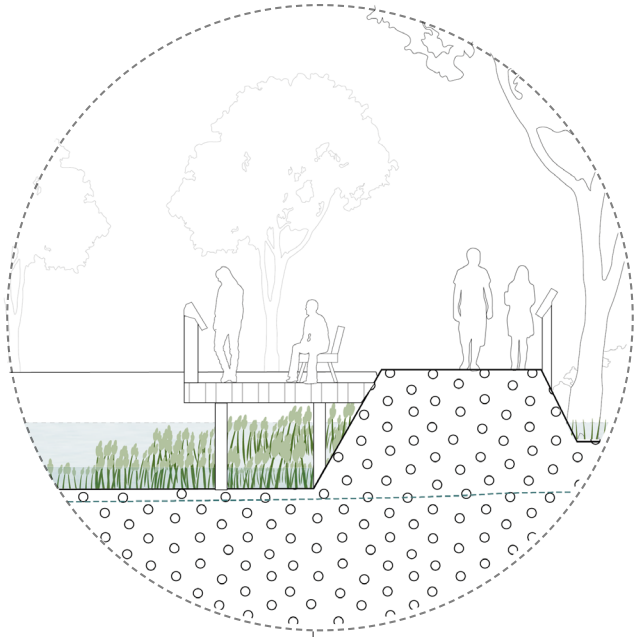
Interventions:

Tidal park

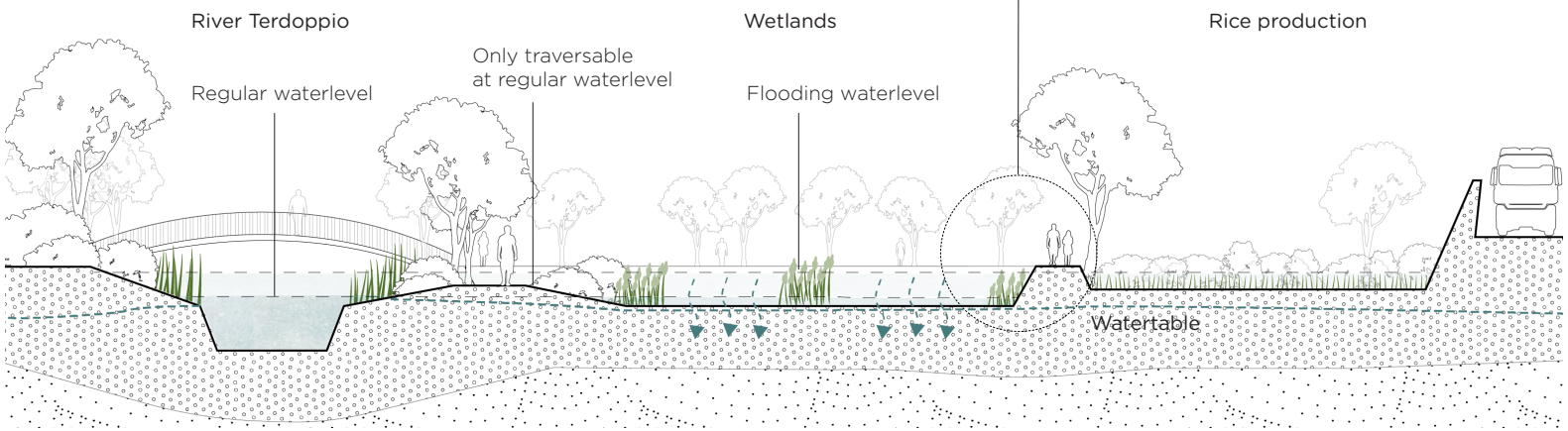
Natural (A) and artificial (B) water inlet



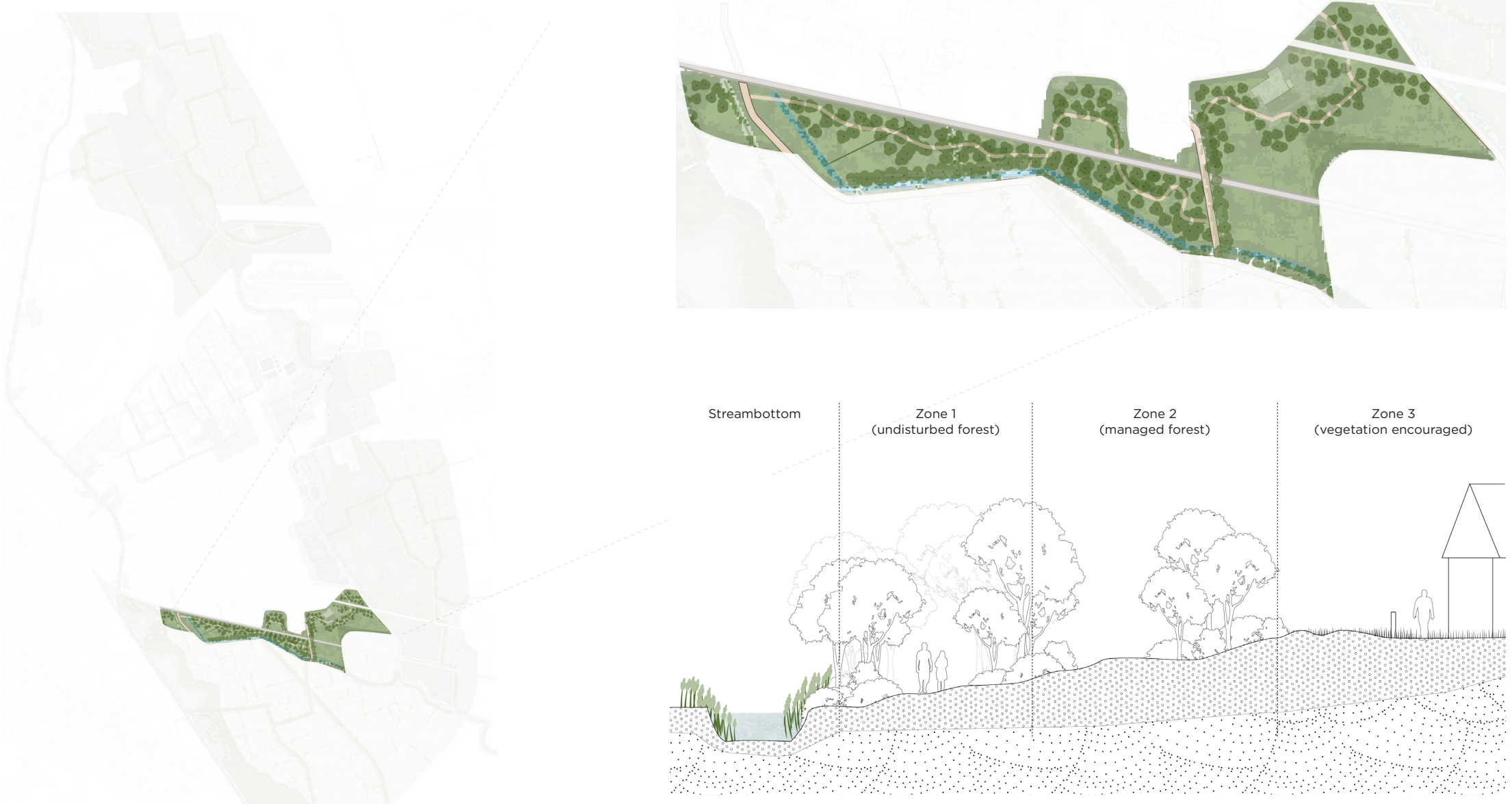
Stimulating engagement & awareness



Highlighting multifunctioinality by different water levels



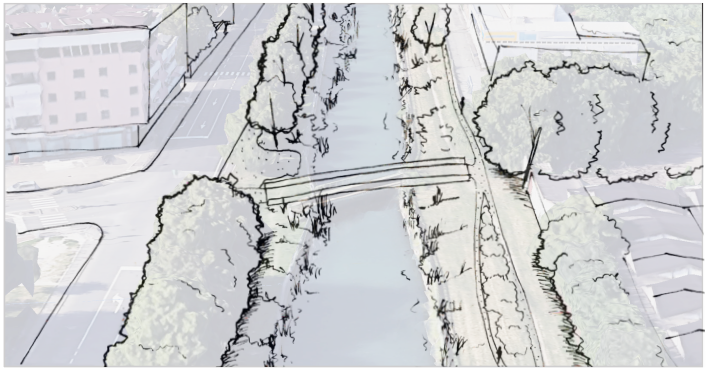
Interventions:
Riparian buffer

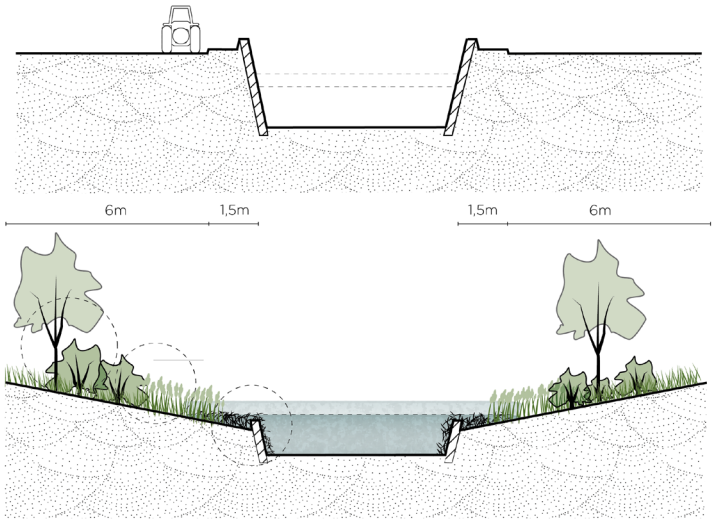


Interventions:
Nature-friendly banks

Urban renaturalisation and quality

A

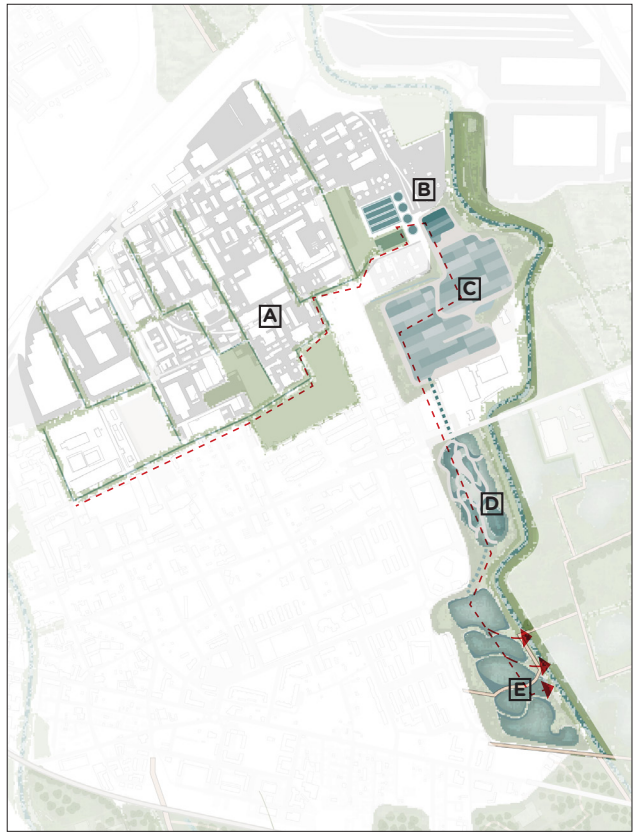


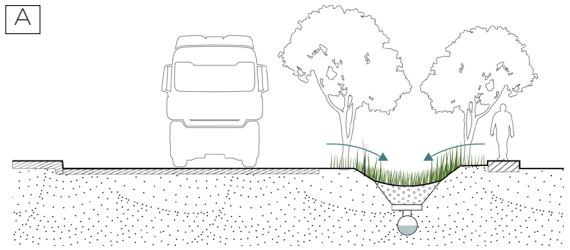


Connection to wetlands and alluvial forests

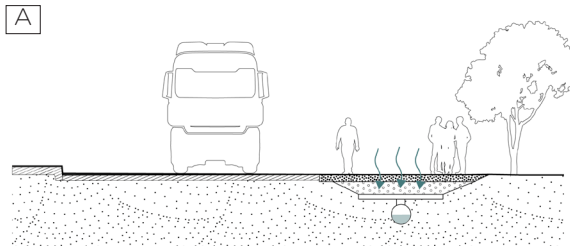
B

Interventions:
Filtration park

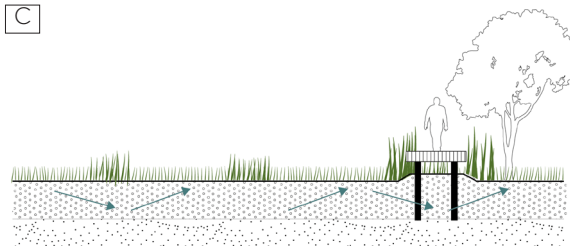




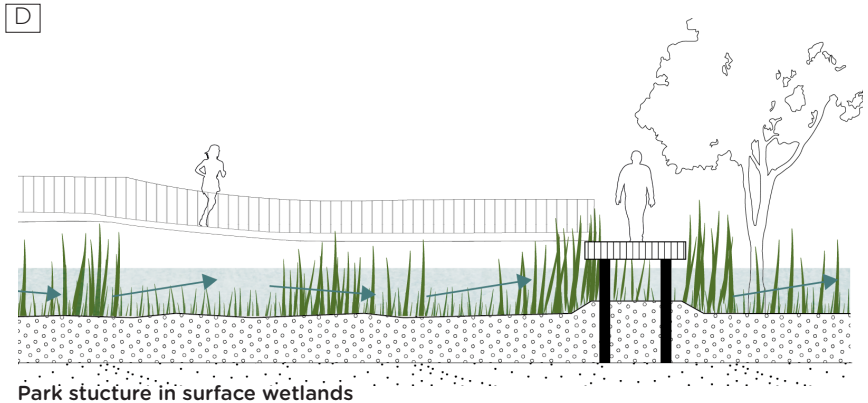
Semi-natural ditches



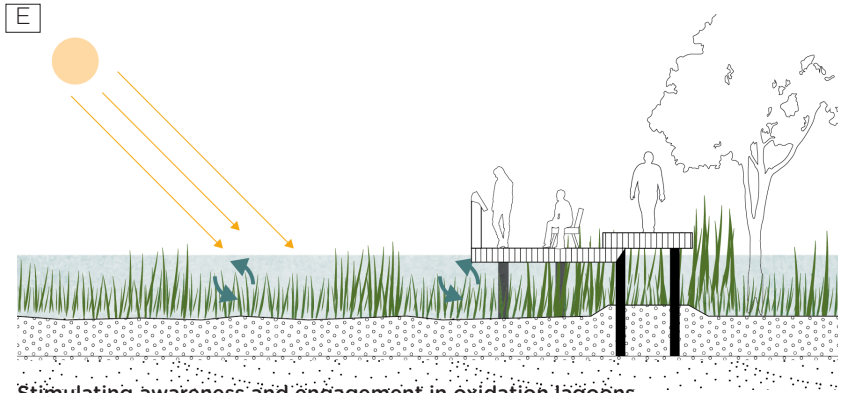
Artificial ditches



Pollution travels “subsoil”



Park stucture in surface wetlands



Stimulating awareness and engagement in oxidation lagoons

A. Industry runoff water

Source: Basch, (2020)

B. Primary filtration

Source: (NCH, 2017)

C. Subsurface wetlands

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

D. Surface wetlands

Source: (NATIVE PLANT SOLUTIONS & New Jersey Developers Green Infrastructure Guide 2.0, 2018)

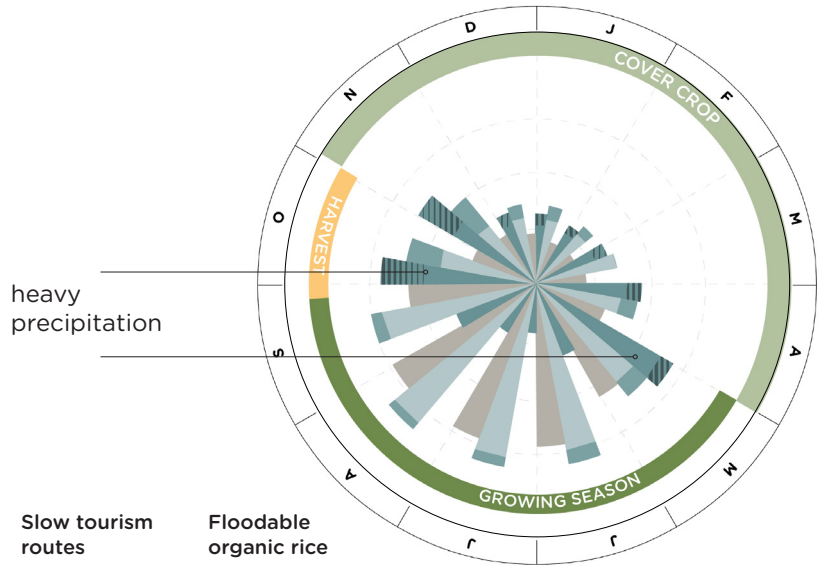
E. Oxidation lagoons

Source: (Figueiras, 2017)

Seasonal dynamics:
excessive water

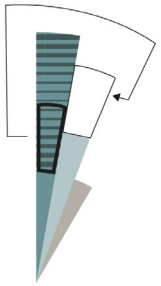
- Strenthen resilience by allowing flooding
- Replenish water table

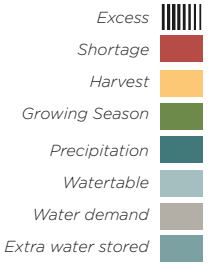
New watercycle

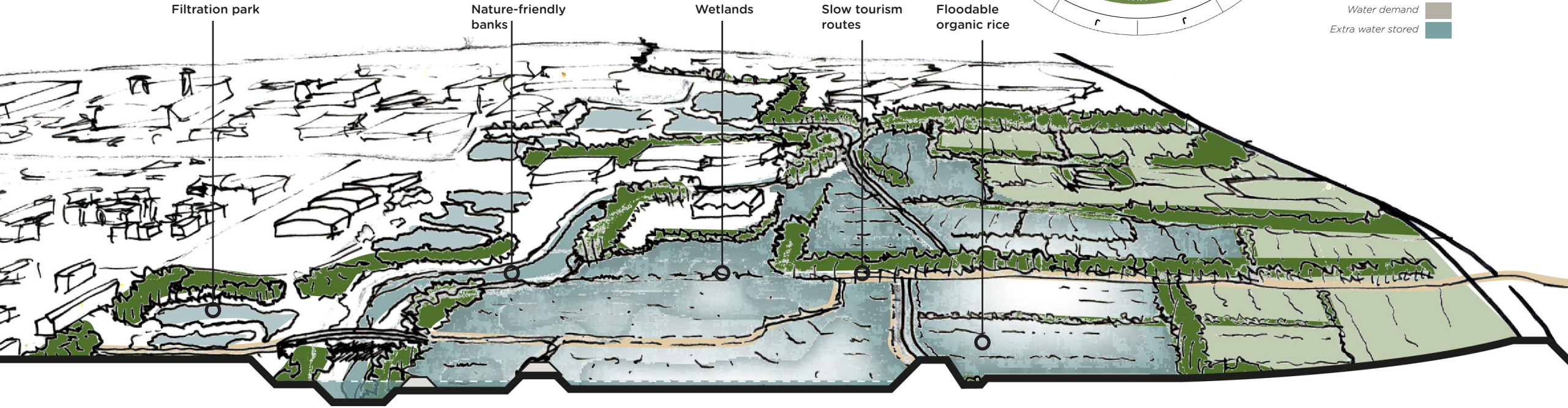


heavy precipitation

Excess water replenishes watertable



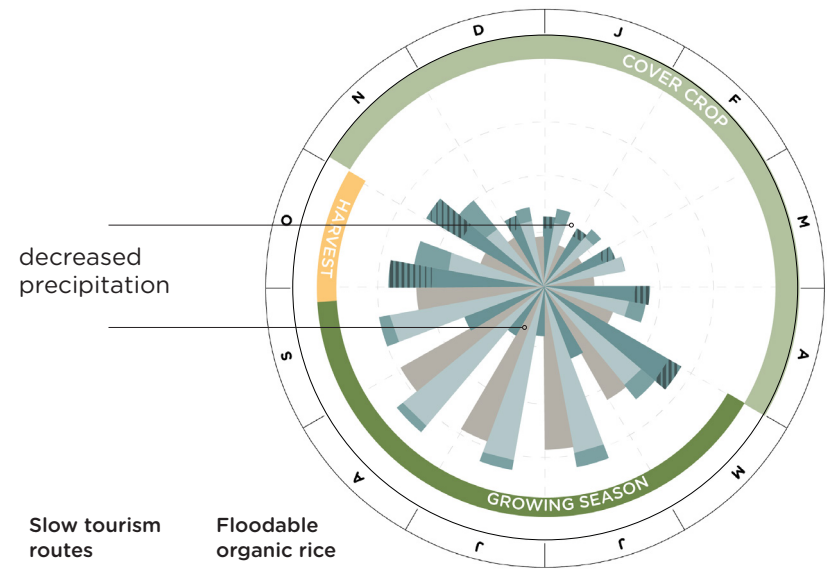




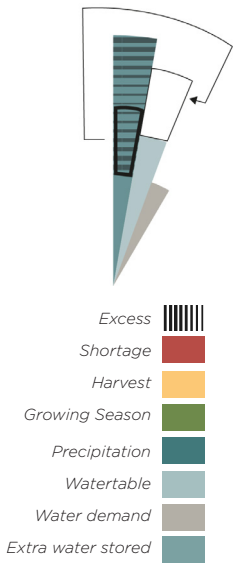
Seasonal dynamics:
regular situation

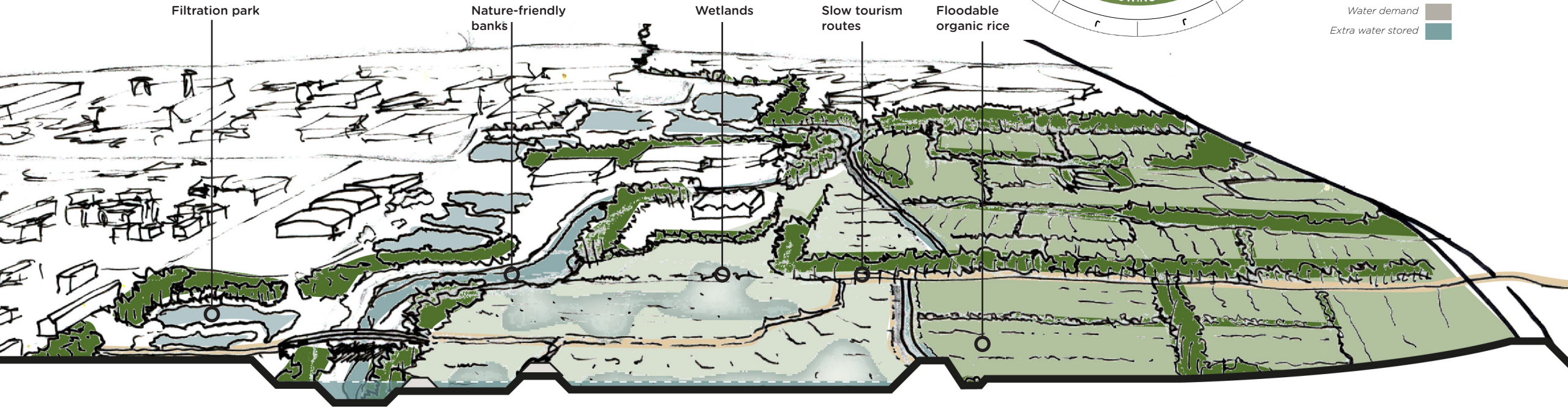
- Allow wetness
- Sustain hydrological balance necessary for ecological performance and rice production

New watercycle



Excess water replenishes watertable

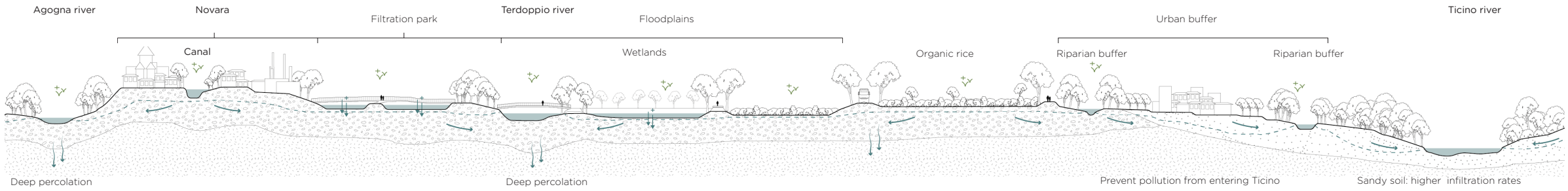




CONCLUSION

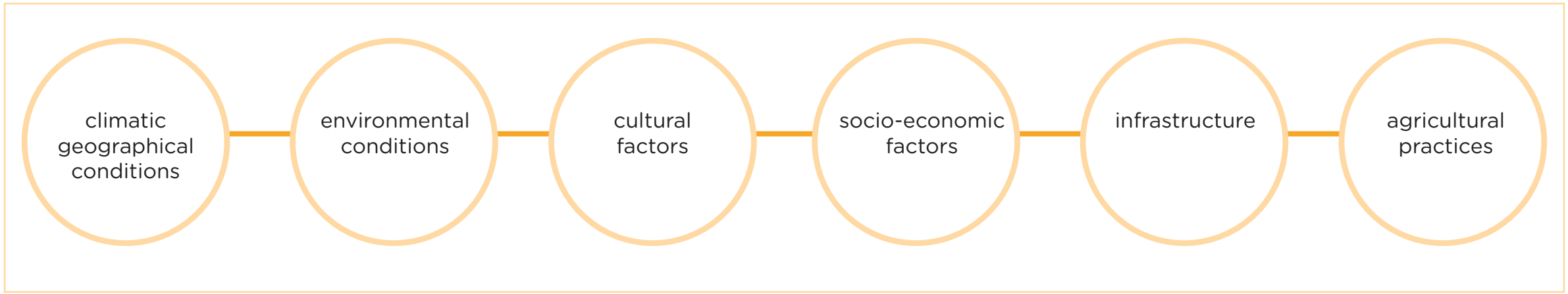
How can design reinforce habitat provision in rice production, enhance water security and improve the connection between humans and nature in the urban rural context of Novara?

This strategy addresses urban and rural **challenges** through **opportunistic** and **multifunctional** design. It **embraces the natural dynamics of environments** and shows how safeguarding the health of ecosystems reinforces their resilience to environmental challenges. This can be harnessed to support human life. By **integrating nature** into interventions and stimulating engagement with inhabitants, the approach aims to **reconnect people** with their environment, demonstrating nature's capacity to adapt to the effects of climate change. In this way, it **reinforces** the current system of **cultural landscape** through a **holistic** and **integrated** approach to water management and agricultural practices.

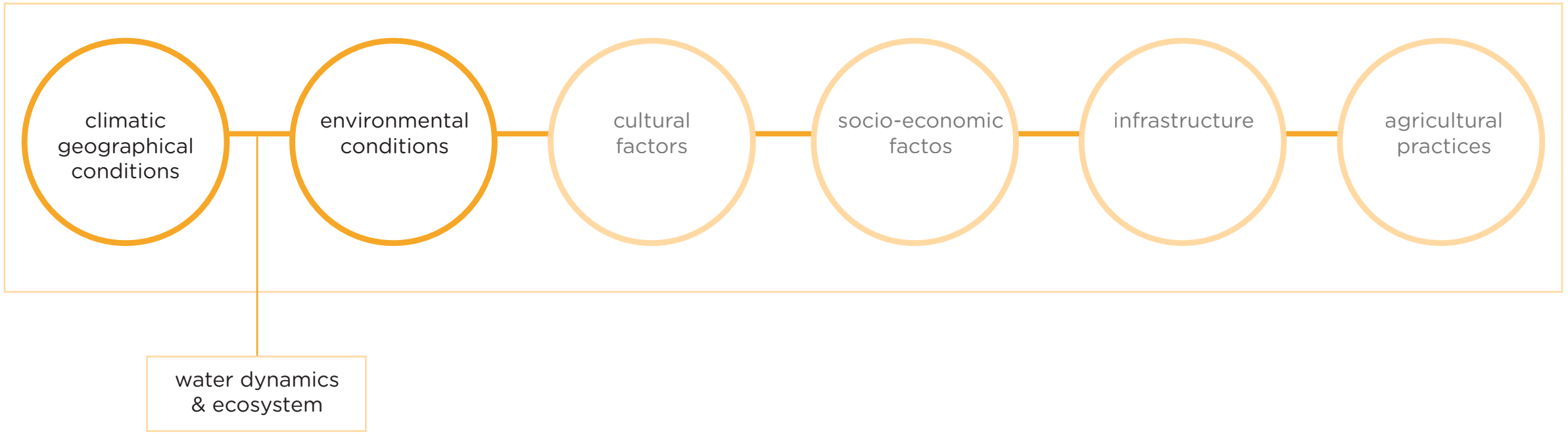


Transferability

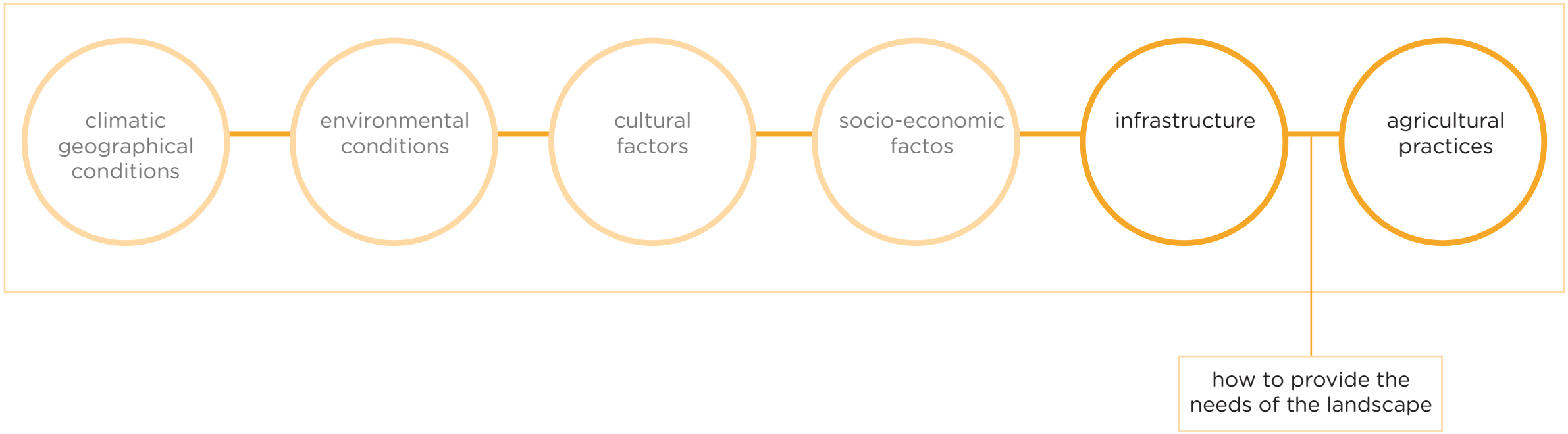
- Project is tailored specific climatic and geographical conditions, challenging transferability



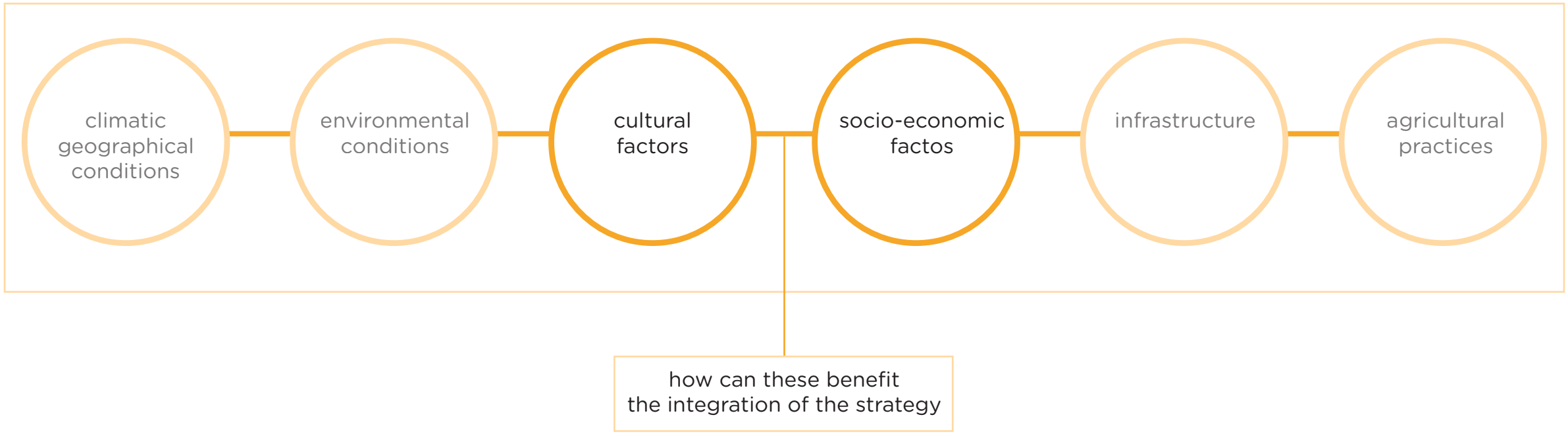
Transferability



Transferability



Transferability

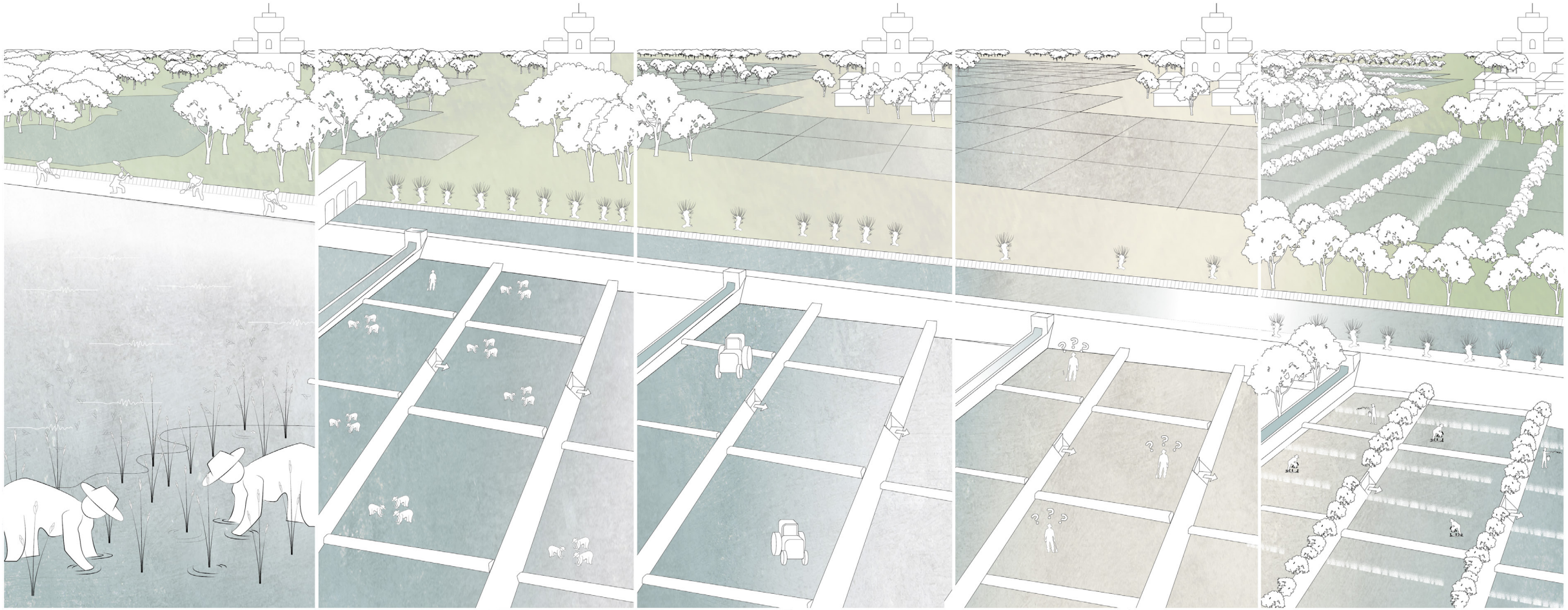


Is rice actually sustainable?

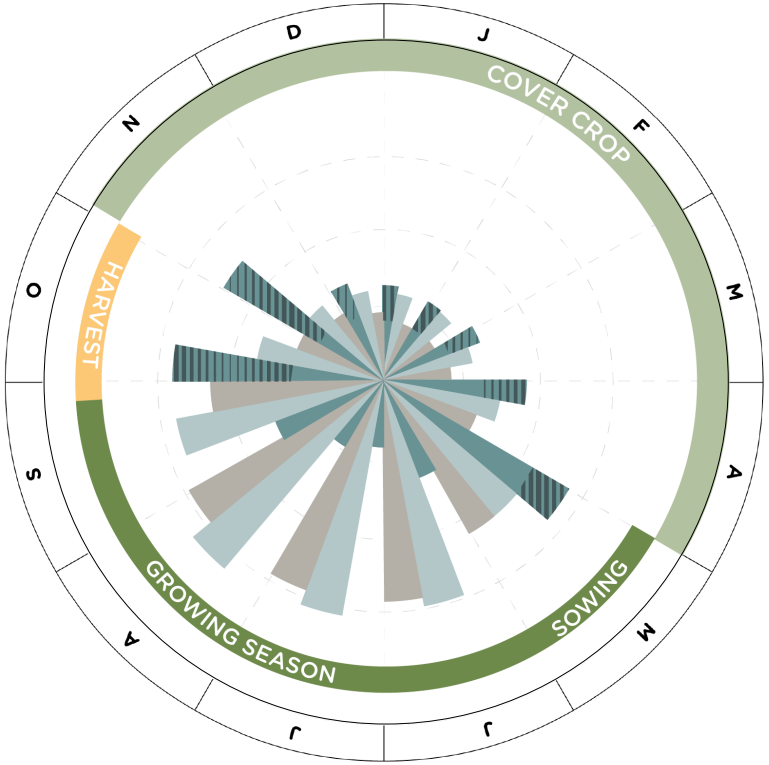
Can we predict the climate?

How do you influence a human-nature relationship?

Re-imagining the Integration of Cultivation and Ecosystems

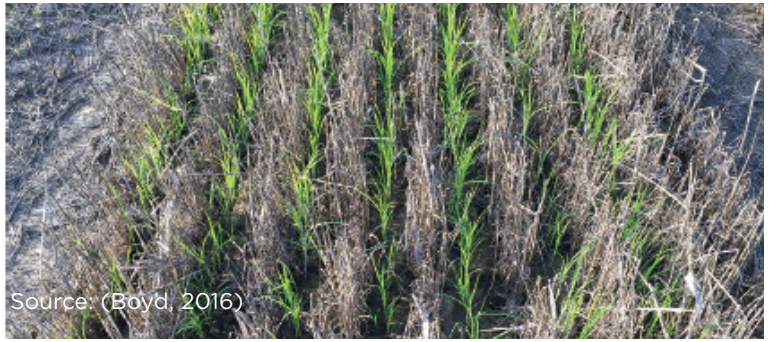


Interventions:
Organic rice



Precipitation
Watertable
Water demand
Excess
Harvest
Growing Season

Green mulching (cover crop)



Flattening

Sowing

Growing & harvest

Figure 4.4: Dynamics of organic rice production.

References

Amante, A. (2023c, juni 7). Italy's drought: desalination plants and new infrastructure needed to save the country. We Build Value. https://www.webuildvalue.com/en/global-economy-sustainability/italy-drought.html

Basch, R. (2020, 24 juli). Foliage feature: Bioswales — Hunters Point Parks Conservancy. Hunters Point Parks Conservancy. https://www.hunterspointparks.org/hppc-blog/2020/7/24/foliage-feature-bioswales

Bertacche, M. (2022, 30 juni). Italy's Drought Worsens as Salty Sea Creeps Further Into Vital River. Bloomberg. https://www.bloomberg.com/news/articles/2022-06-30/italy-s-drought-worsens-as-salty-sea-creeps-into-vital-po-river

BluTaco. (2023, 15 maart). La semina del Riso e l'importanza dell'Acqua. Cascina Battivacco. https://cascinabattivacco.it/la-semina-del-riso-e-limportanza-dellacqua/

Briggs, G. M. (z.d.). Rice. Pressbooks. https://milnepublishing.geneseo.edu/botany/chapter/rice/

D'Amico, A., Ciulla, G., Panno, D., & Ferrari, S. (2019). Building energy demand assessment through heating degree days: The importance of a climatic dataset. Applied Energy, 242, 1285–1306. https://doi.org/10.1016/j.apenergy.2019.03.167

Farr, C. (2022, 2 mei). The challenges of the global rice market. AgronoMag. https://agronomag.com/challenges-global-rice-market/

Figueiras, S. (2017, 16 januari). The ultimate day trip: Hong Kong Wetland Park. Green Queen. https://www.greenqueen.com.hk/hong-kong-wetlands-park/

Giorgio, A. (2023, 18 augustus). ECCO DOVE FINISCE L'ACQUA DELLA RISAIA. RisoItaliano | Il Portale Del Riso. https://www.risoitaliano.eu/ecco-dove-finisce-lacqua-della-risaia/

Hong Kong Wetland Park | Hong Kong Tourism Board. (z.d.). Discover Hong Kong. https://www.discoverhongkong.com/nl/interactive-map/hong-kong-wetland-park.html

King, A. (2023, 13 juli). Light headed: Stressed Northwest wheat may yield disappointing harvest. Northwest Public Broadcasting. https://www.nwpb.org/2023/07/13/light-headed-stressed-northwest-wheat-may-yield-disappointing-harvest/

luPi d., CenGhiAltA C., COlOmbO m., 2009 - Adult feeding by the rice water weevil Lissorhoptrus oryzophilus on different host plants. Bull. of Insectology 62 (2): 229-236

Lupi, D., Colombo, M., Giudici, M. L., Villa, B., Cenghialta, C., & Passoni, D. (2010). On the spatial spread of the Rice Water Weevil, Lissorhoptrus oryzophilus Kuschel (Coleoptera: Erirhinidae), in Italy. Journal Of Entomological And Acarological Research, 42(2), 81. https://doi.org/10.4081/jear.2010.81

NATIVE PLANT SOLUTIONS & New Jersey Developers Green Infrastructure Guide 2.0. (2018). Subsurface Gravel Wetland - New Jersey Future Green Infrastructure Developers Guide. New Jersey Future Green Infrastructure Developers Guide. https://developers-guide.njfuture.org/bmp/subsurface-gravel-wetland/

NCH. (2017, 20 juli). Article | Primary treatment of wastewater. Nchasia. https://www.nchasia.com/en-sg/primary-treatment-of-wastewater/

New Food. (2021, 22 juli). Extrusion of cereals - New Food Magazine. New Food Magazine. https://www.newfoodmagazine.com/article/2515/extrusion-of-cereals/

Organic No-Till & Cover cropping - Wild Hope Farm. (z.d.). Wild Hope Farm. https://www.wildhopefarm.com/organic-lowtill

Ozbun, T. (2022, 18 januari). Planted area of rice in Italy 2018, by region. Statista. https://www.statista.com/statistics/796695/planted-area-of-rice-by-region-in-italy/

Phelan, K. (2020, 18 juni). Growing Seed Corn: Is It Right for You? IGSE Manufacturing. https://www.igsemfg.com/post/growing-seed-corn-is-it-right-for-you

Population Media Center. (2023, 28 juni). Ending population growth — a helpful solution. https://www.populationmedia.org/the-latest/ending-population-growth-a-helpful-solution

Riso Italiano. (2018c, mei 3). STOCCHI: VI RACCONTO MARIO PIANESI. RisoItaliano | Il Portale Del Riso. https://www.risoitaliano.eu/stocchi-vi-racconto-mario-pianesi/

Risoitaliano, R. (2023, 13 april). NUOVE SEMINE ANTI-SICCITA' RisoItaliano | Il Portale Del Riso. https://www.risoitaliano.eu/52549-2/

Thompson, J. (2013, 18 oktober). Wheat Production Considerations | Panhandle Agriculture. https://nwdistrict.ifas.ufl.edu/phag/2013/10/18/wheat-production-considerations/

Ward, M. (2023, 11 januari). Missouri's rice industry grows through research. https://www.farmprogress.com/rice/missouri-s-rice-industry-grows-through-research

The Editors of Encyclopaedia Britannica. (2024, 21 juni). Corn | History, Cultivation, Uses, & Description. Encyclopedia Britannica. https://www.britannica.com/plant/corn-plant