Delft University of Technology
MSC Architecture, Urbanism and Building Sciences
Sanne van Rees

RIPPLES OF RESILIENCE

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

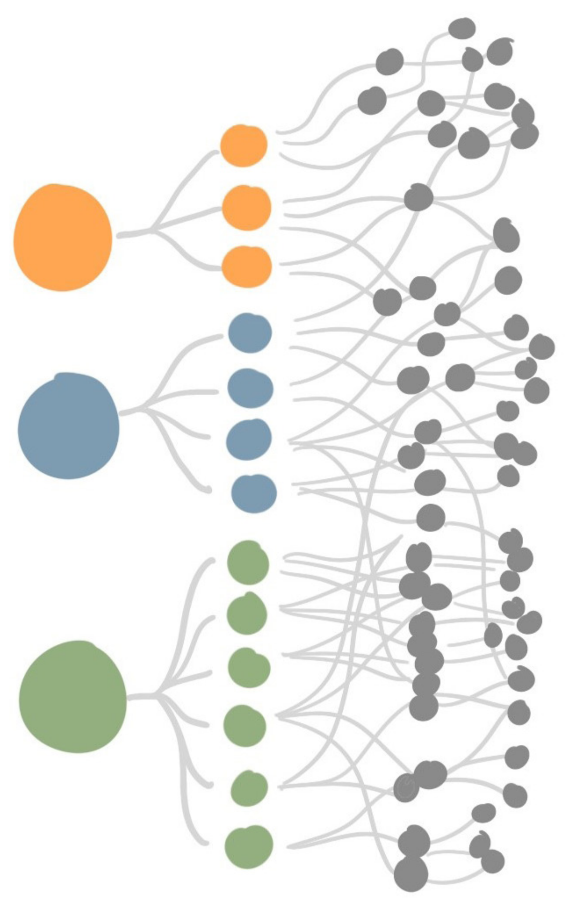
23-06-2025
A. Wandl & V. Muñoz-Sanz
P5 presentation

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

introduction — theory — methodology — analysis — design — conclusion

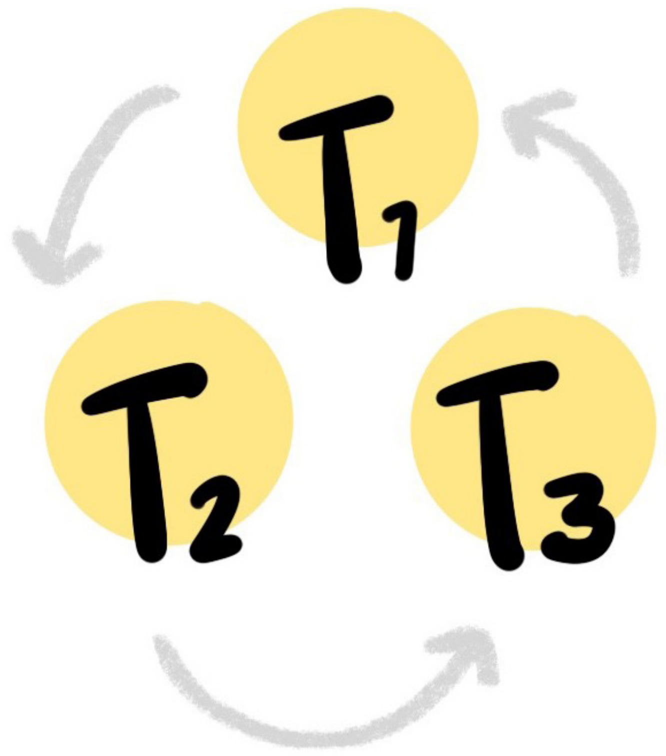
A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

1 A SYMBIOTIC PATHWAY PATTERN LANGUAGE



2 A REGIONAL SYMBIOTIC DESIGN STRATEGY

3 SYMBIOTIC SYSTEMIC DESIGN METHODOLOGY

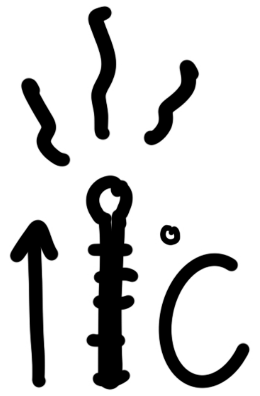


A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

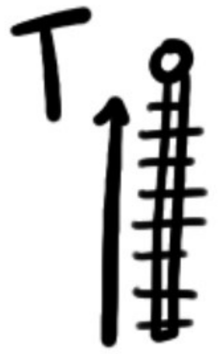
Figure 1. (Scherer, 2023)

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

VARYING PRECIPITATION



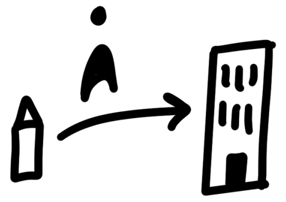
CLIMATE CHANGE



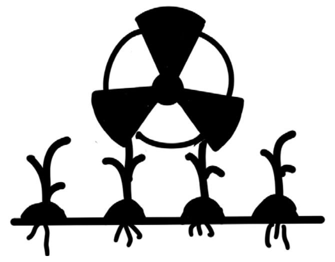
TEMPERATURES

A LACK OF AVAILABLE WATER TO MEET THE DEMANDS IN A CERTAIN AREA

POPULATION GROWTH



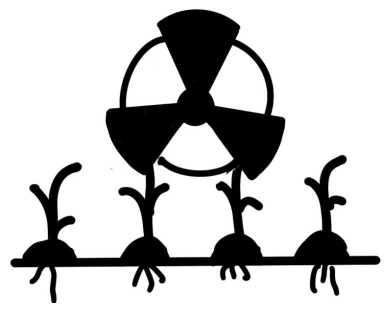
URBANISATION



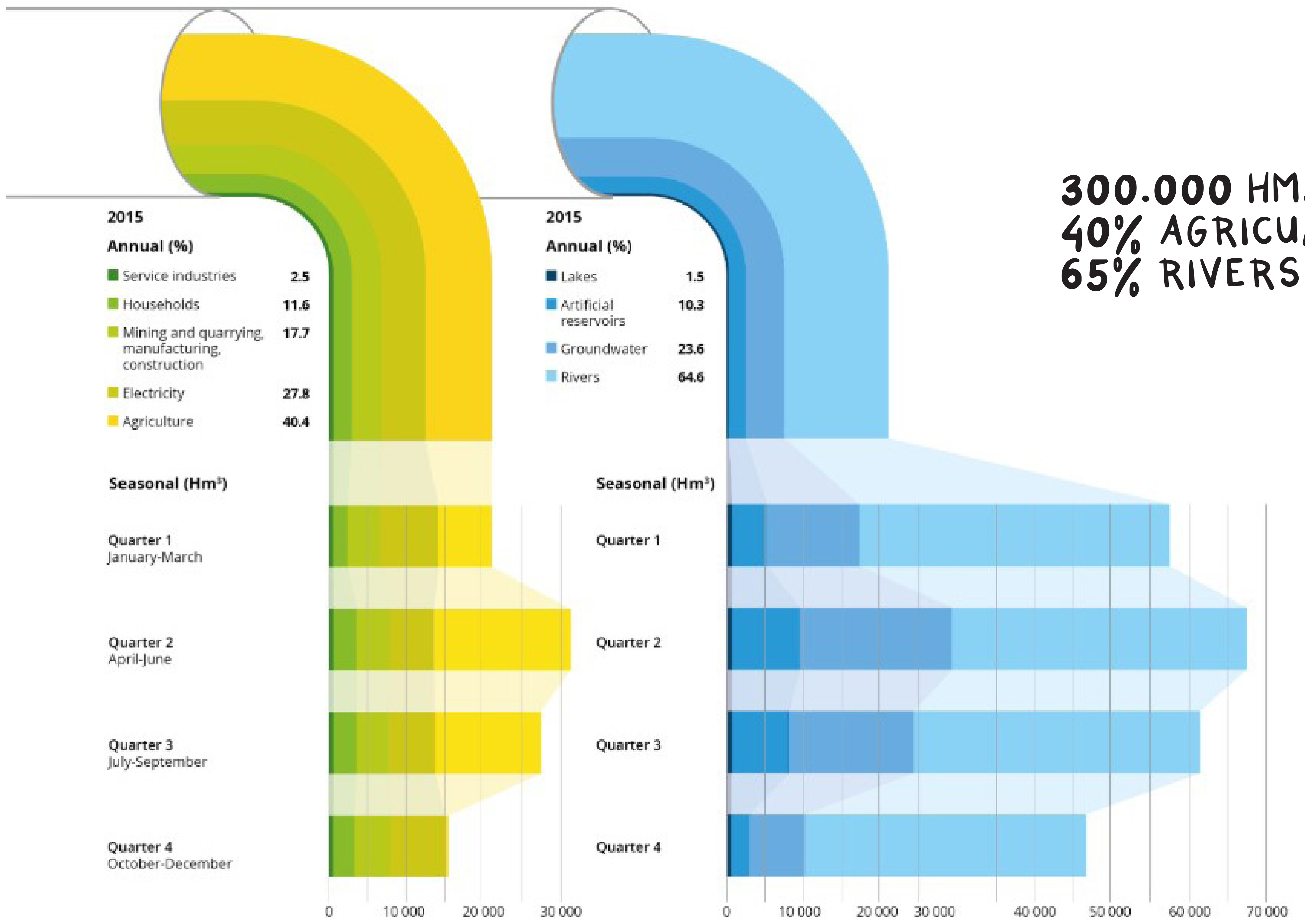
PRODUCTION LANDSCAPES

TOURISM

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.



HIGH WATER DEMANDS



300.000 HM3 ECONOMIC USE
40% AGRICULTURE
65% RIVERS ABSTRACTION

Figure 2. Seasonal green and blue water consumption by industry in the EU for 2015. Source: (EEA, 2025)

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

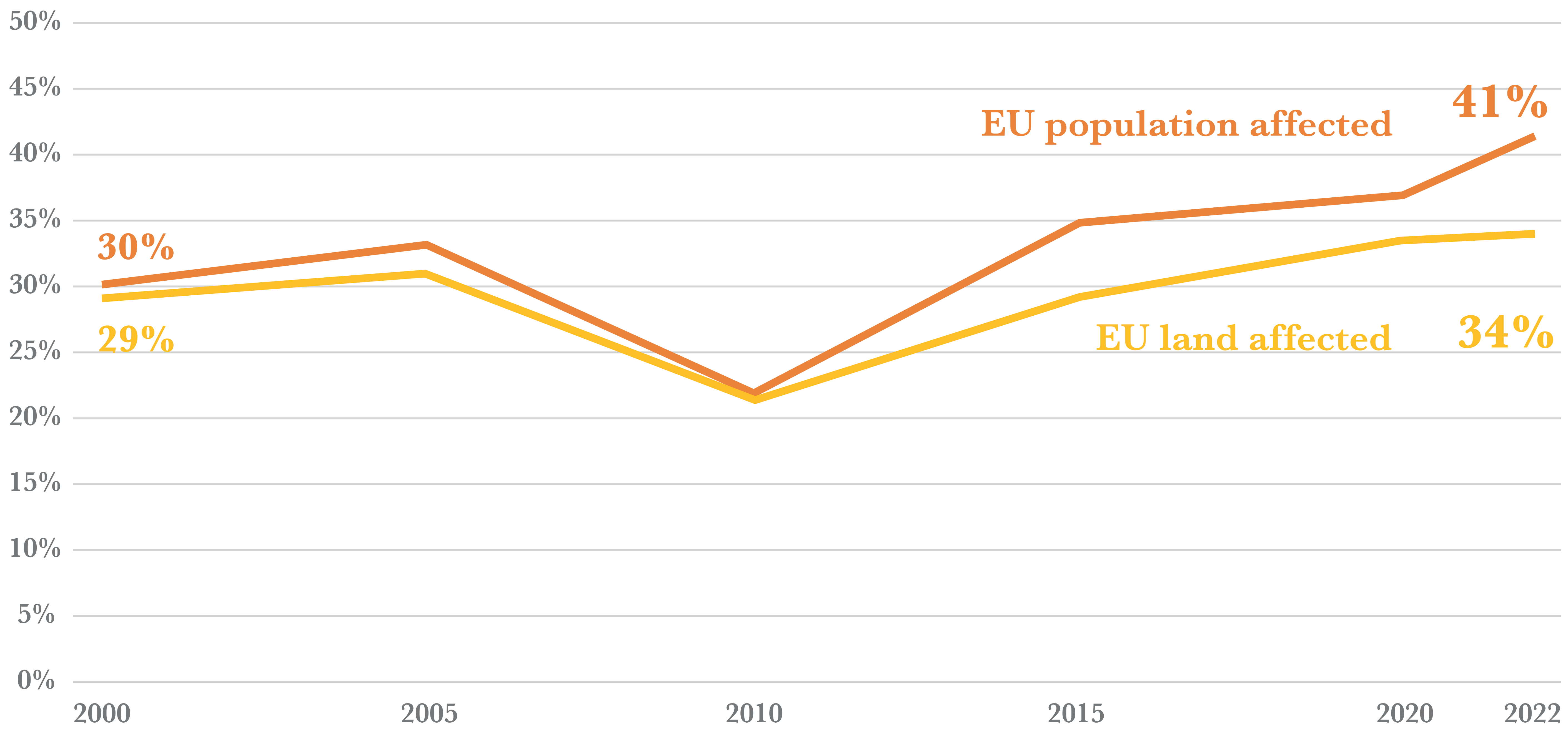


Figure 4. (EEA, 2025)

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

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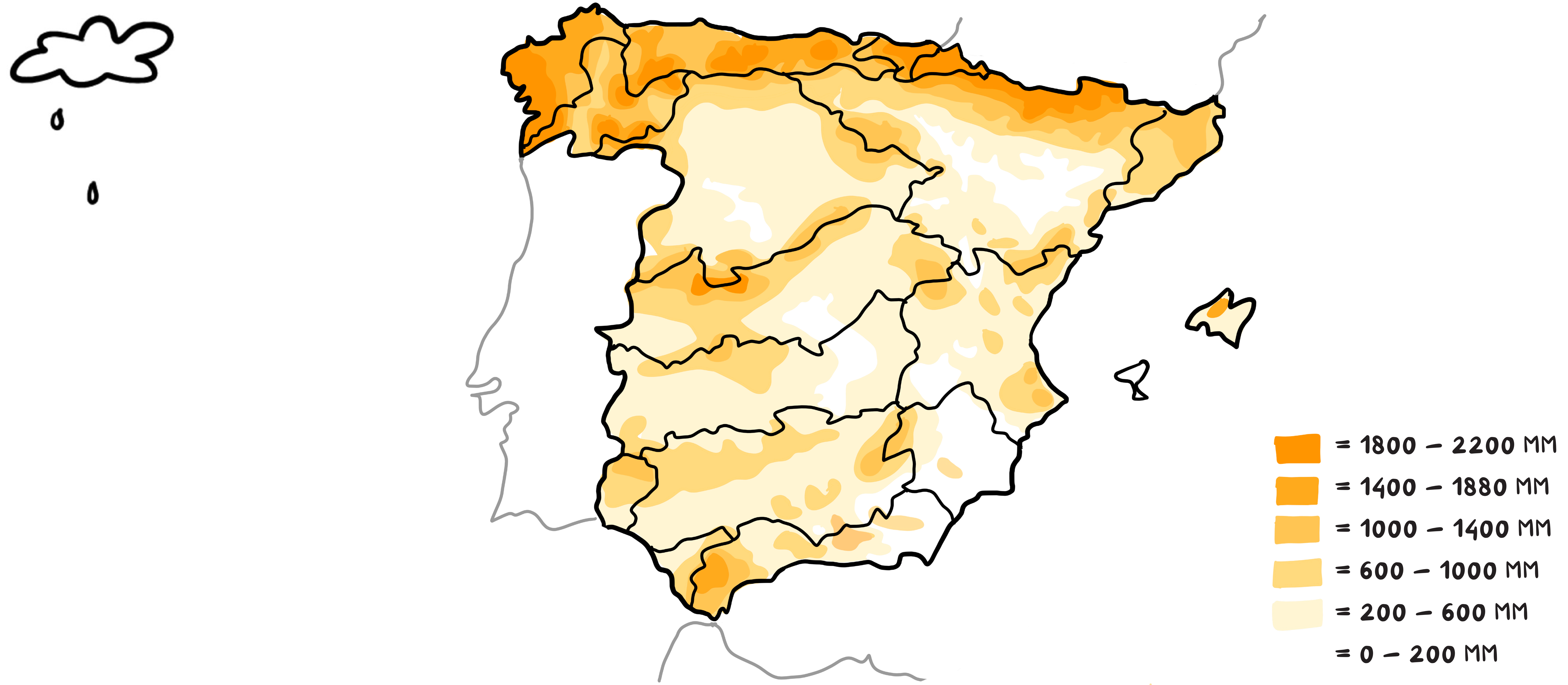
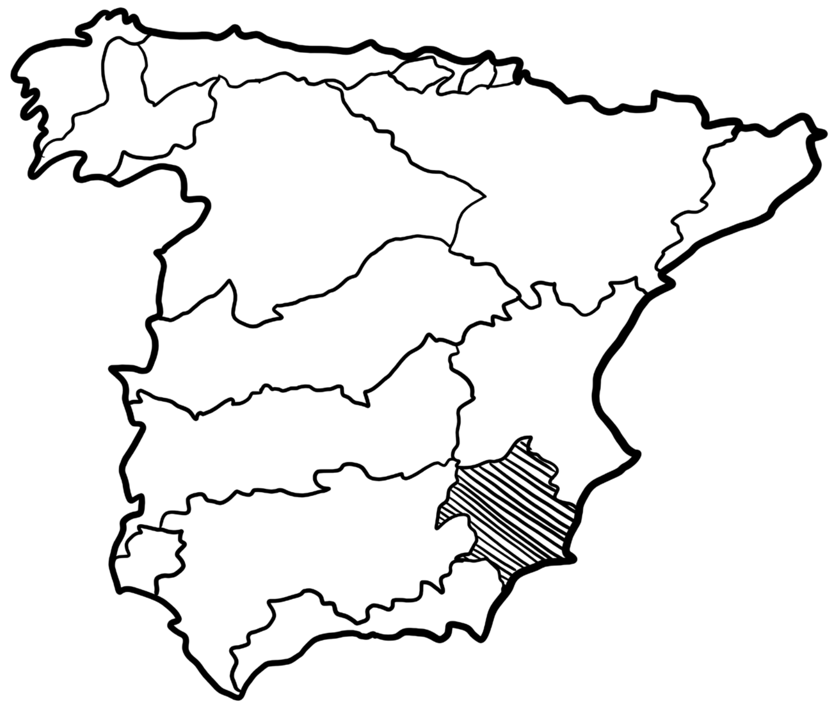
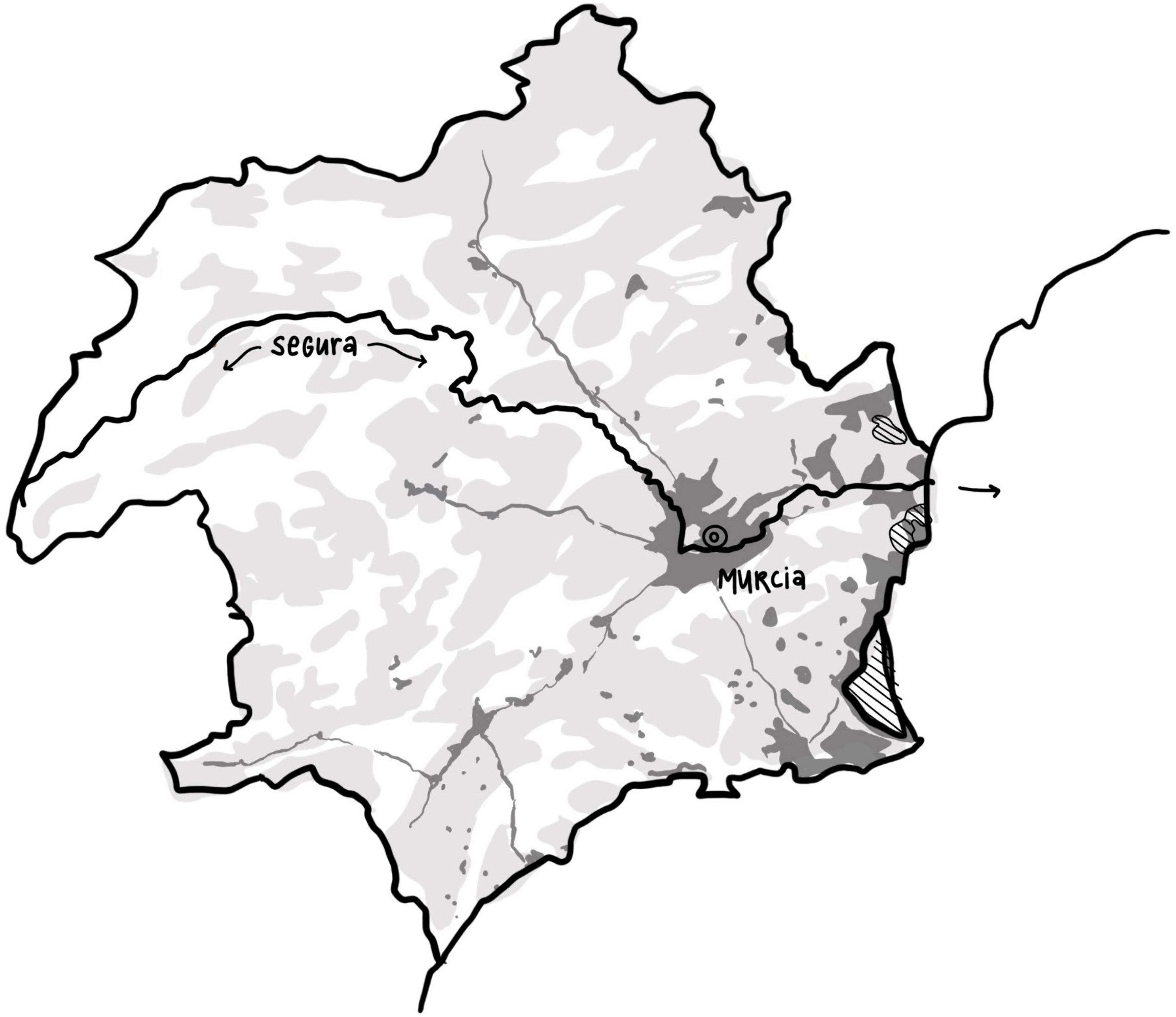


Figure 5. Precipitation map Spain. Source: made by author, based on (Rodriguez-Sanchez & Sarabia-Sánchez, 2020)

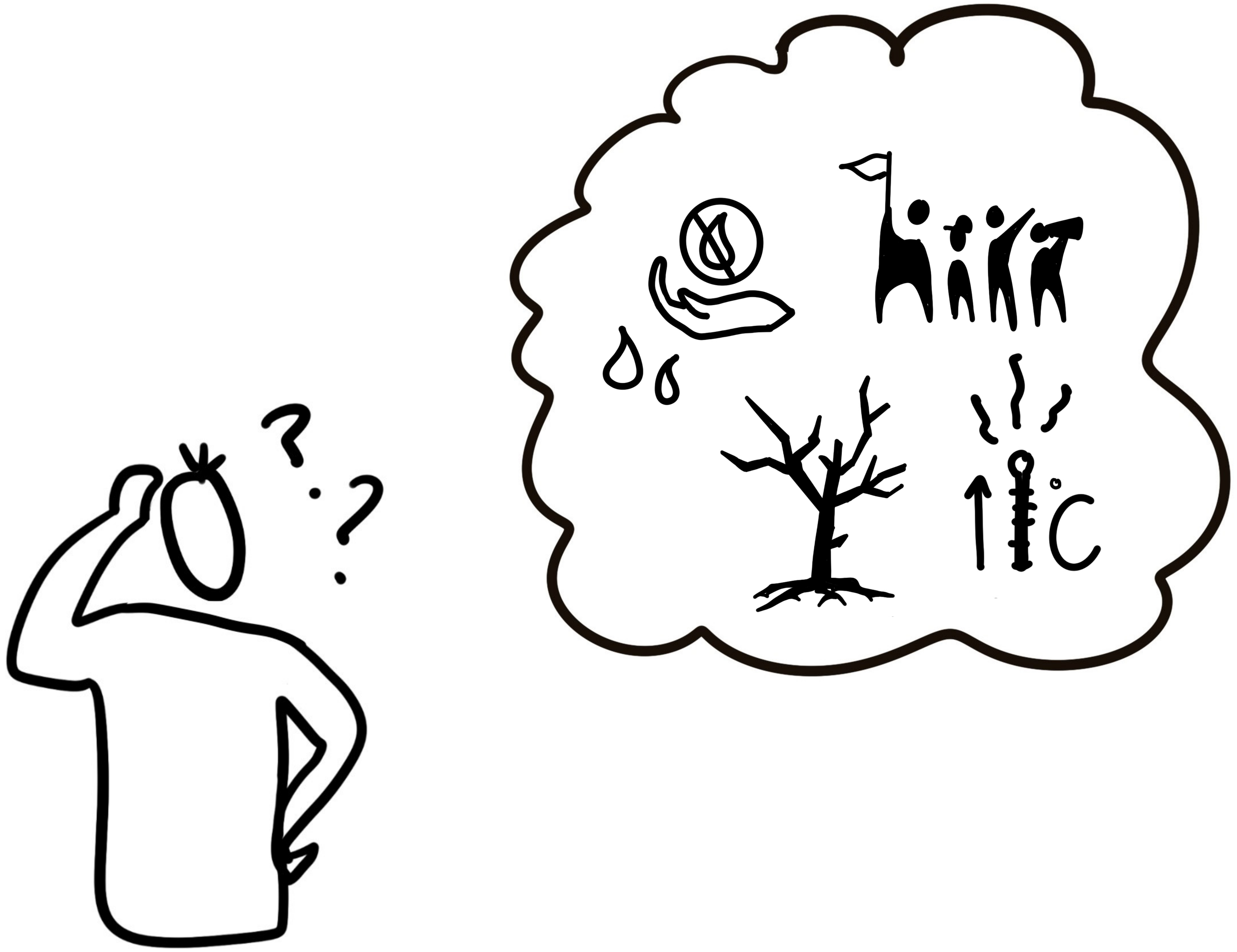
A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.





= IRRIGATED AGRICULTURE
= URBAN AREA
= SEGURA RIVER
= PROTECTED SALINE WETLANDS

A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.



KNOWLEDGE GAP

LACK OF A SYMBIOTIC DESIGN FRAMEWORK FOR THE SYSTEMIC WATER TRANSITION IN ARID AGRICULTURAL REGIONS.

RESEARCH QUESTION ?

HOW COULD **SYMBIOTIC** SYSTEMIC **DESIGN** BE USED TO DEVELOP PATHWAYS FOR THE SUSTAINABLE **WATER SYSTEM TRANSITION**, CONTRIBUTING TO **WATER SECURITY** AND A **SOCIO-ECOLOGICALLY RESILIENT** FUTURE FOR THE SEGURA RIVER BASIN ?

SYMBIOSIS

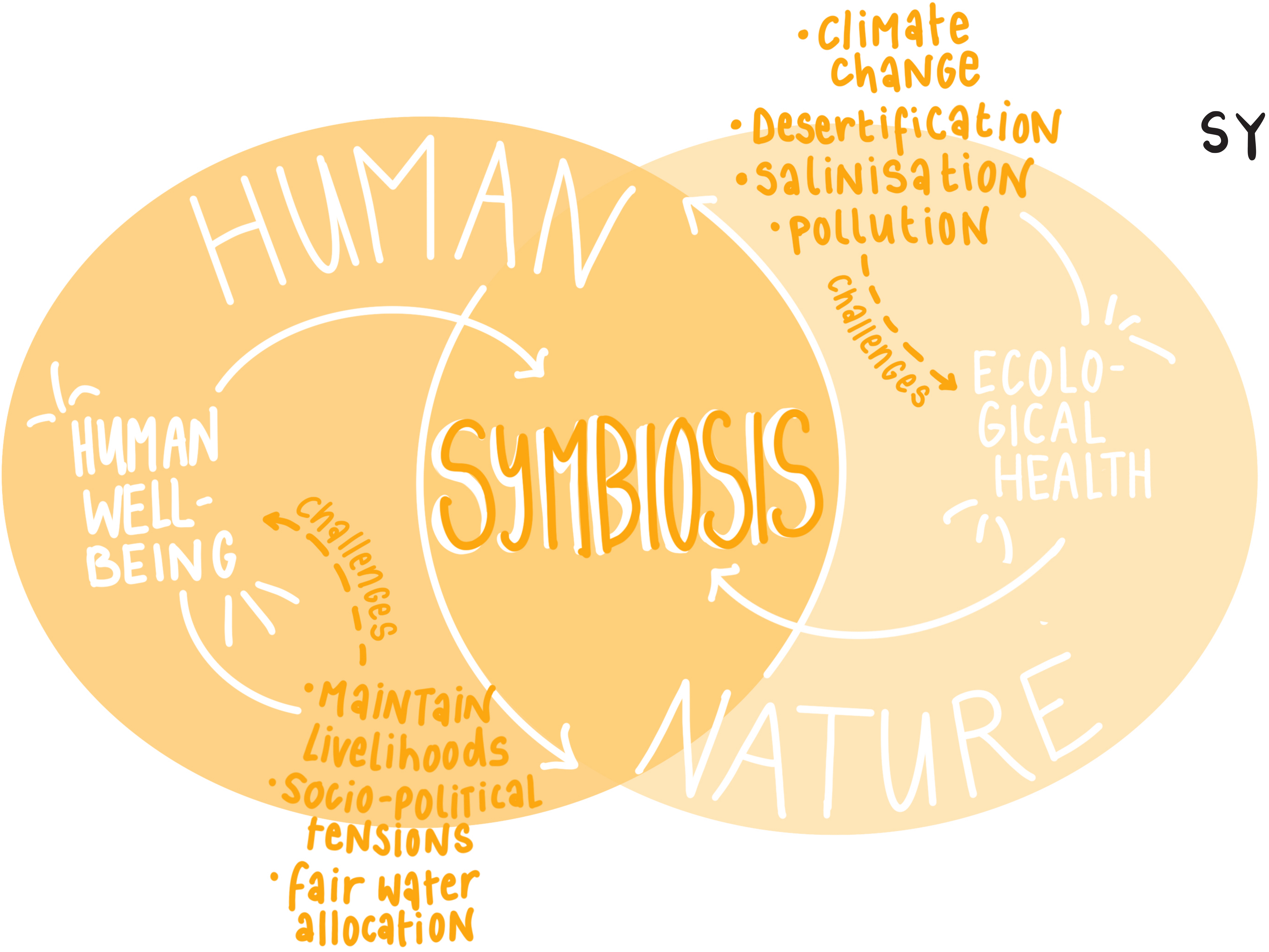


Figure 8. Conceptual framework for a symbiotic water system.

RESILIENCE

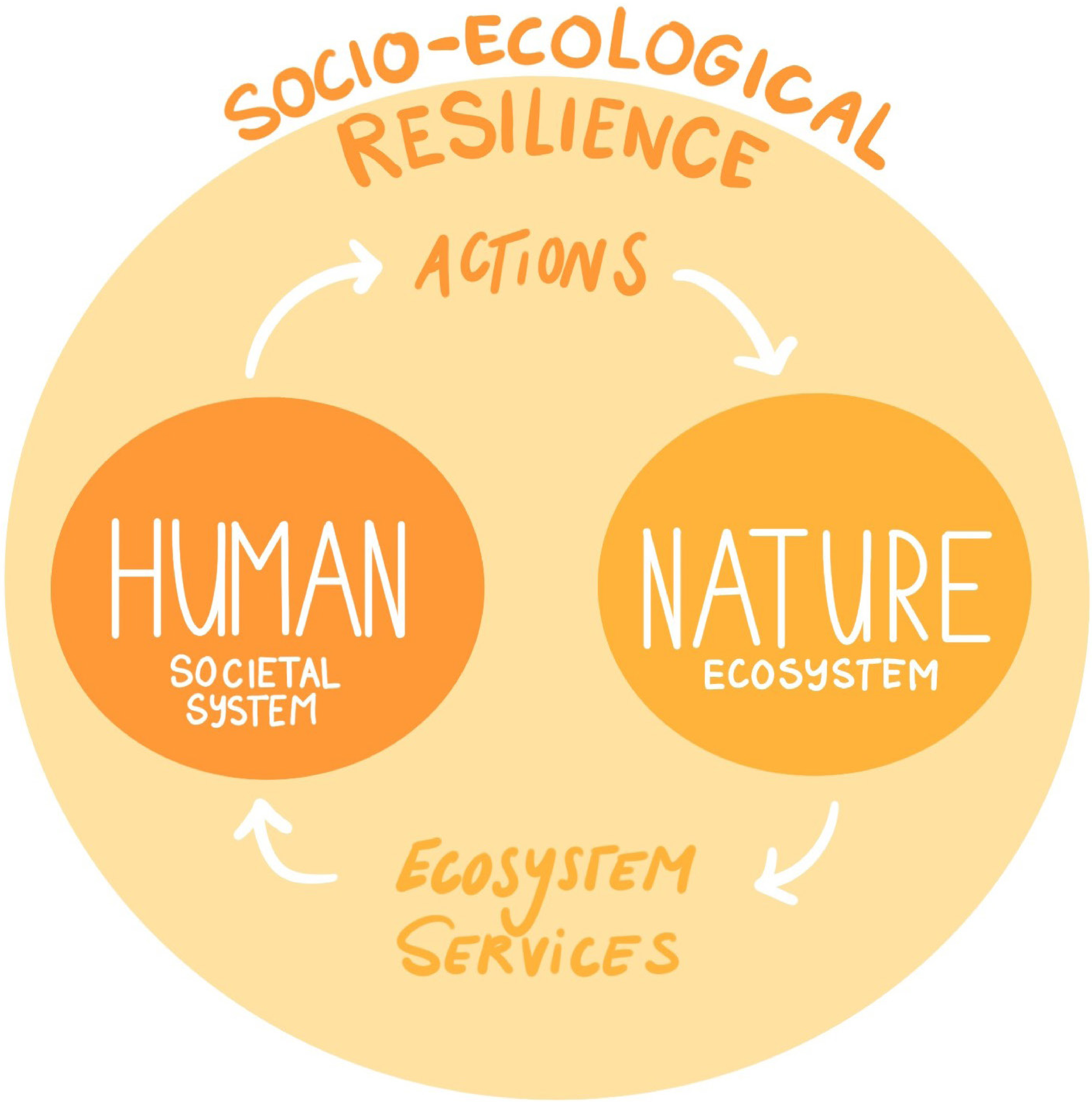


Figure 9. SER (Holling, 1973; Walker et al., 2004; Folke, 2006; Sanchez, 2019).

ADAPTIVE CYCLE

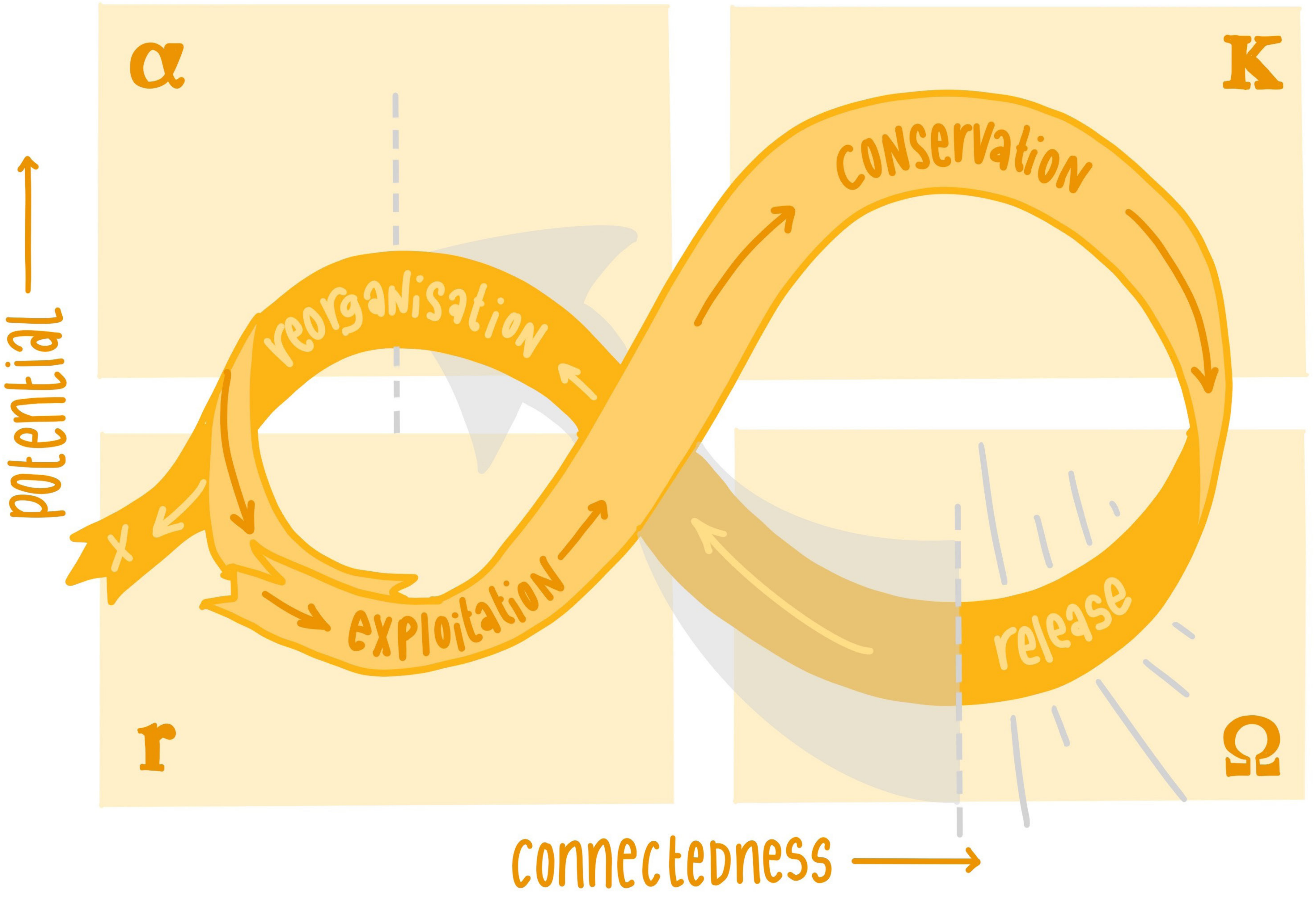
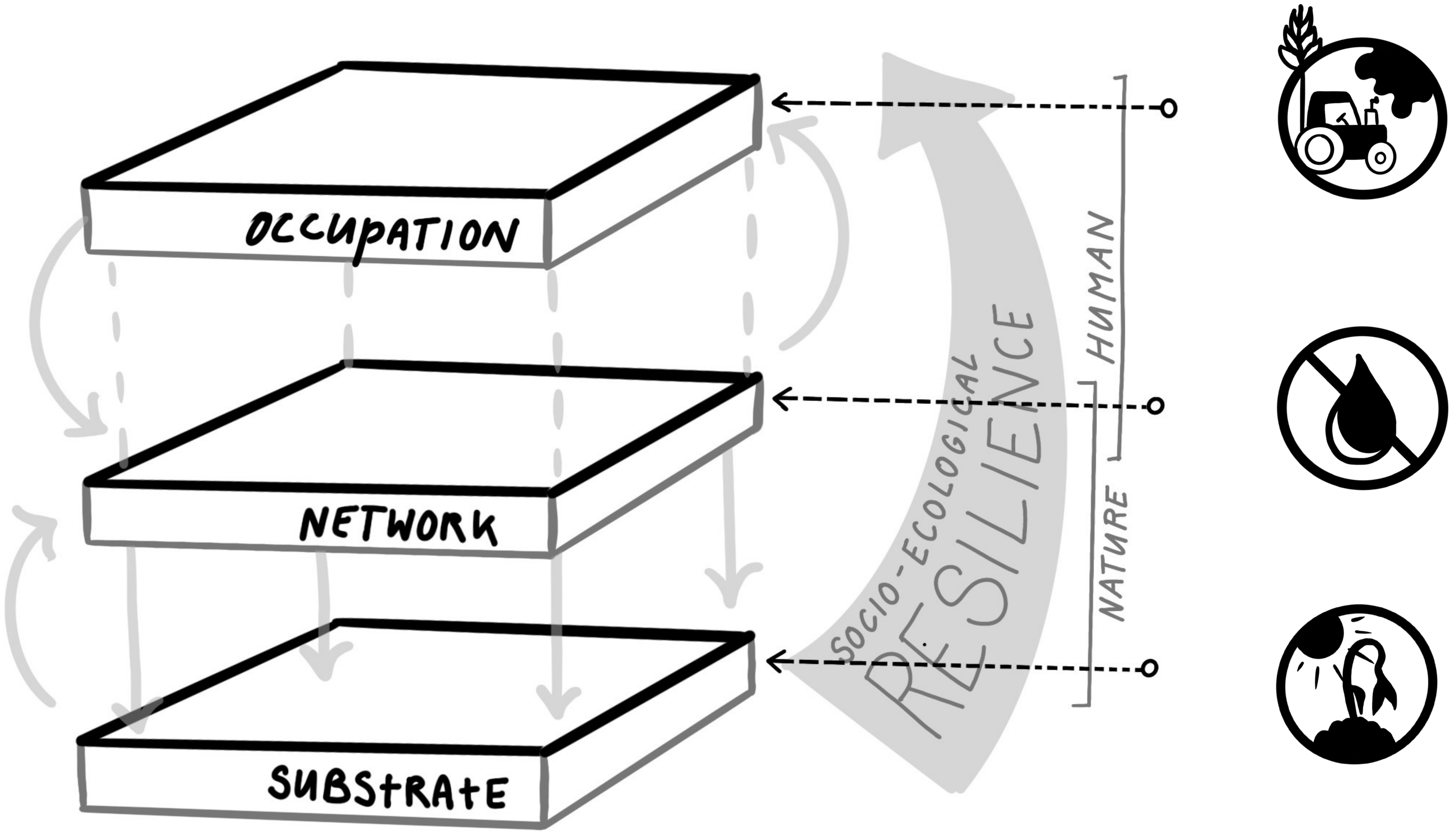


Figure 10. The Adaptice Cycle of the Panarchy Theory. (Gunderson & Holling, 2002).

NETWORK APPROACH



food system

&

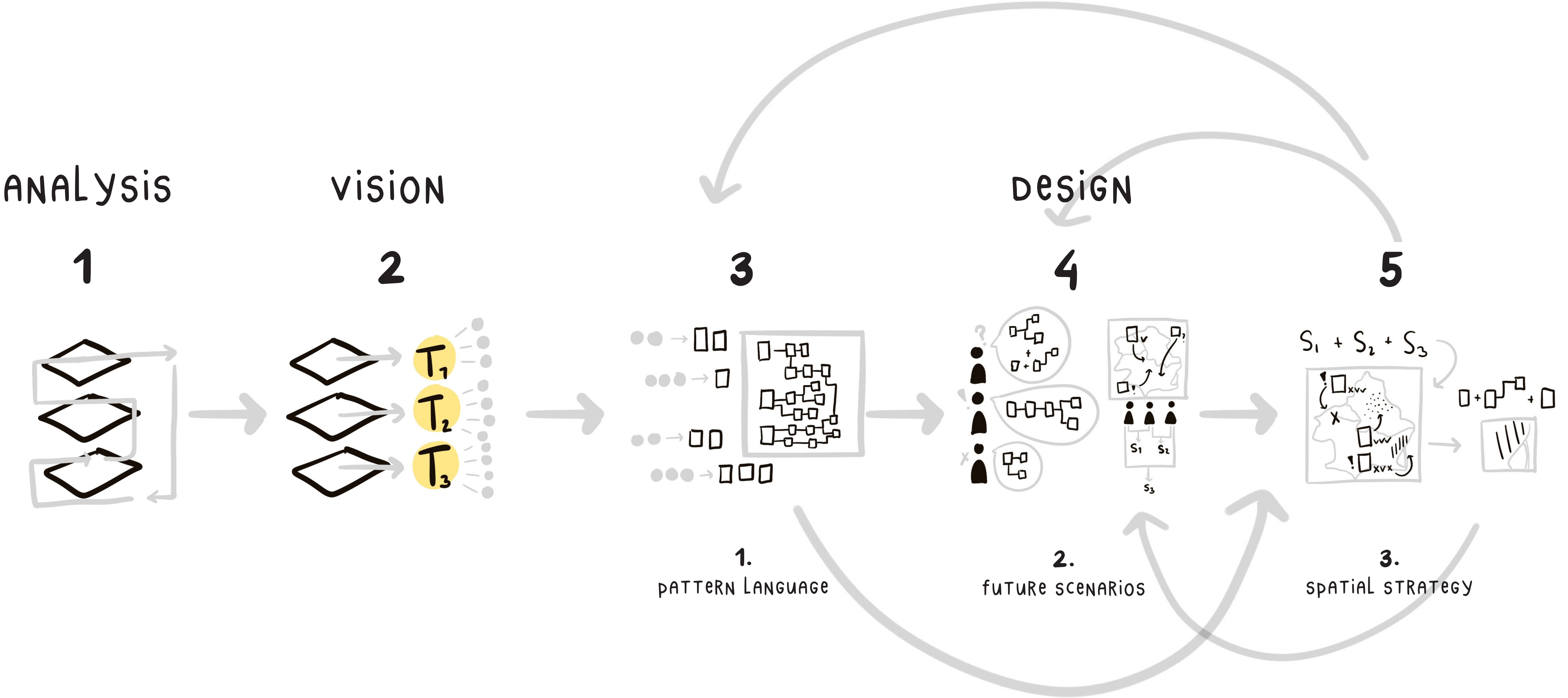
water network

&

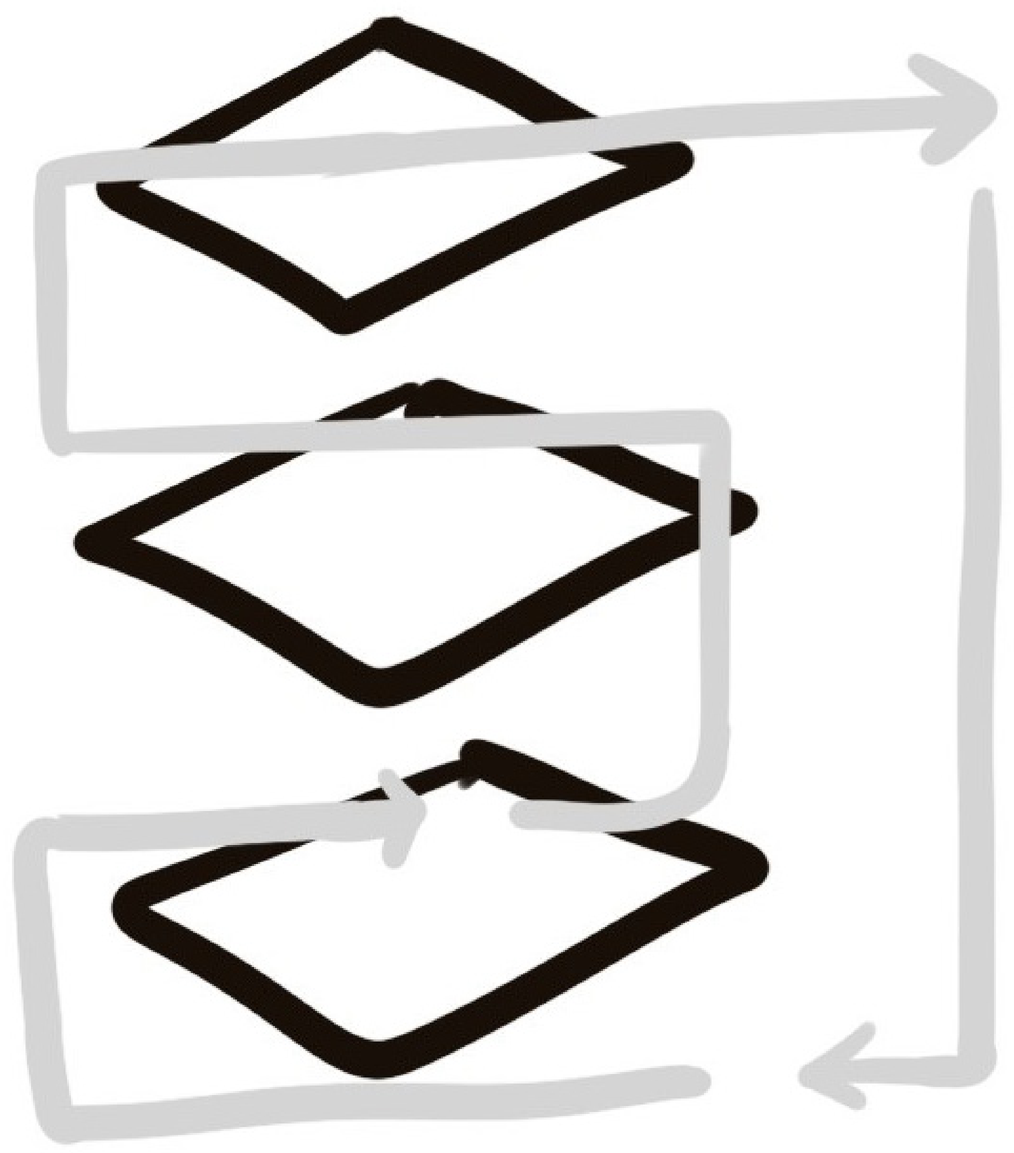
ecosystem

Figure 11. The Network Approach applied to this research. Source: made by author, based on (de Hoog et al., 1998 & Priemus, 2004 & 2007) .

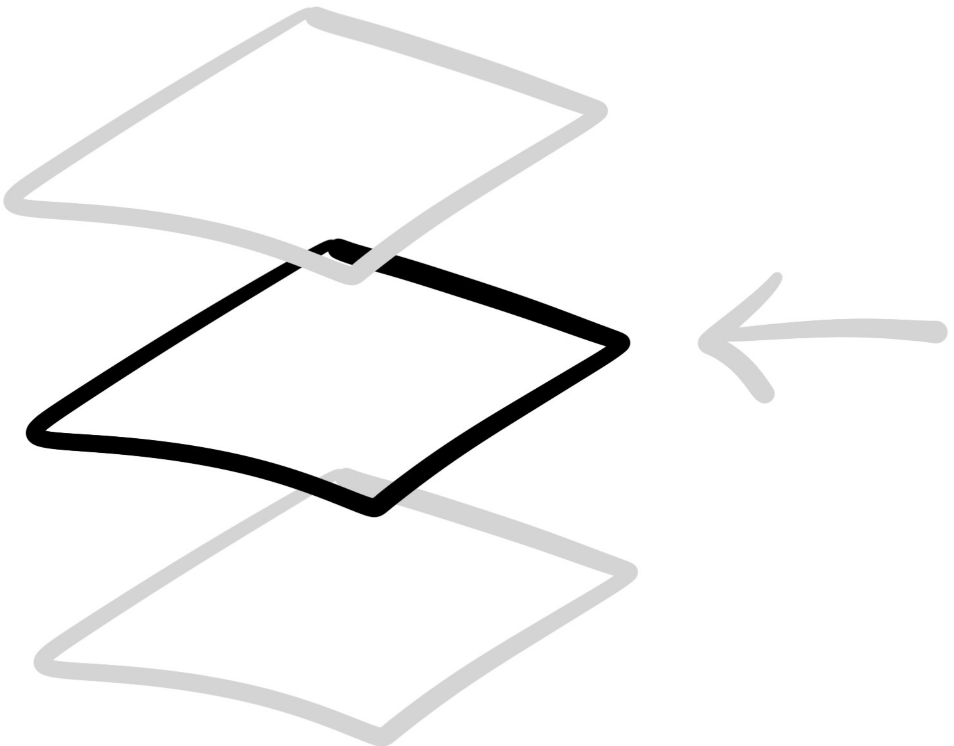
METHODOLOGY



ANALYSIS



HYDRAULIC PARADIGM



SPANISH NHP 1993

WATER IMPORT VOLUME
WATER EXPORT VOLUME
REALISED TRANSFERS
NON REALISED TRANSFERS

Figure 13. National Hydrological Plan of 1933. Source: (Source: YA Newspaper 19.1.1993), adapted from (Lopez-Gunn, 2009)

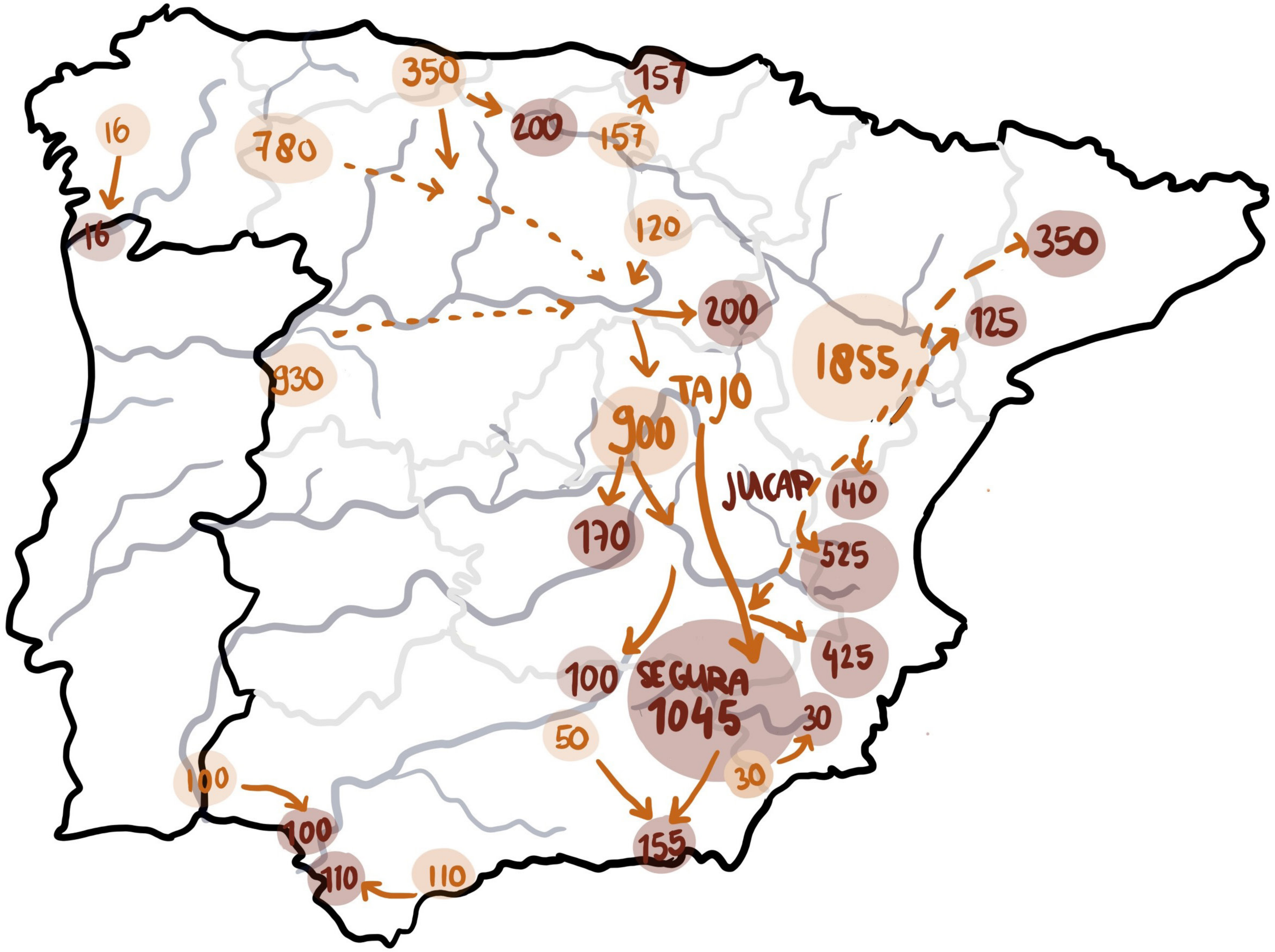


Figure 14. Planned volumes of water through transfers from the Spanish NHP 1993. Source: Made by author.

Figure 16. Image of the TST water supply canal. Made by author.

Figure 15. (RTVE.es, 2015)

TAJO–SEGURA (TST)

Figure 17. Course of the TST in Spain. Source: by author.

SOCIO-POLITICAL CONFLICT

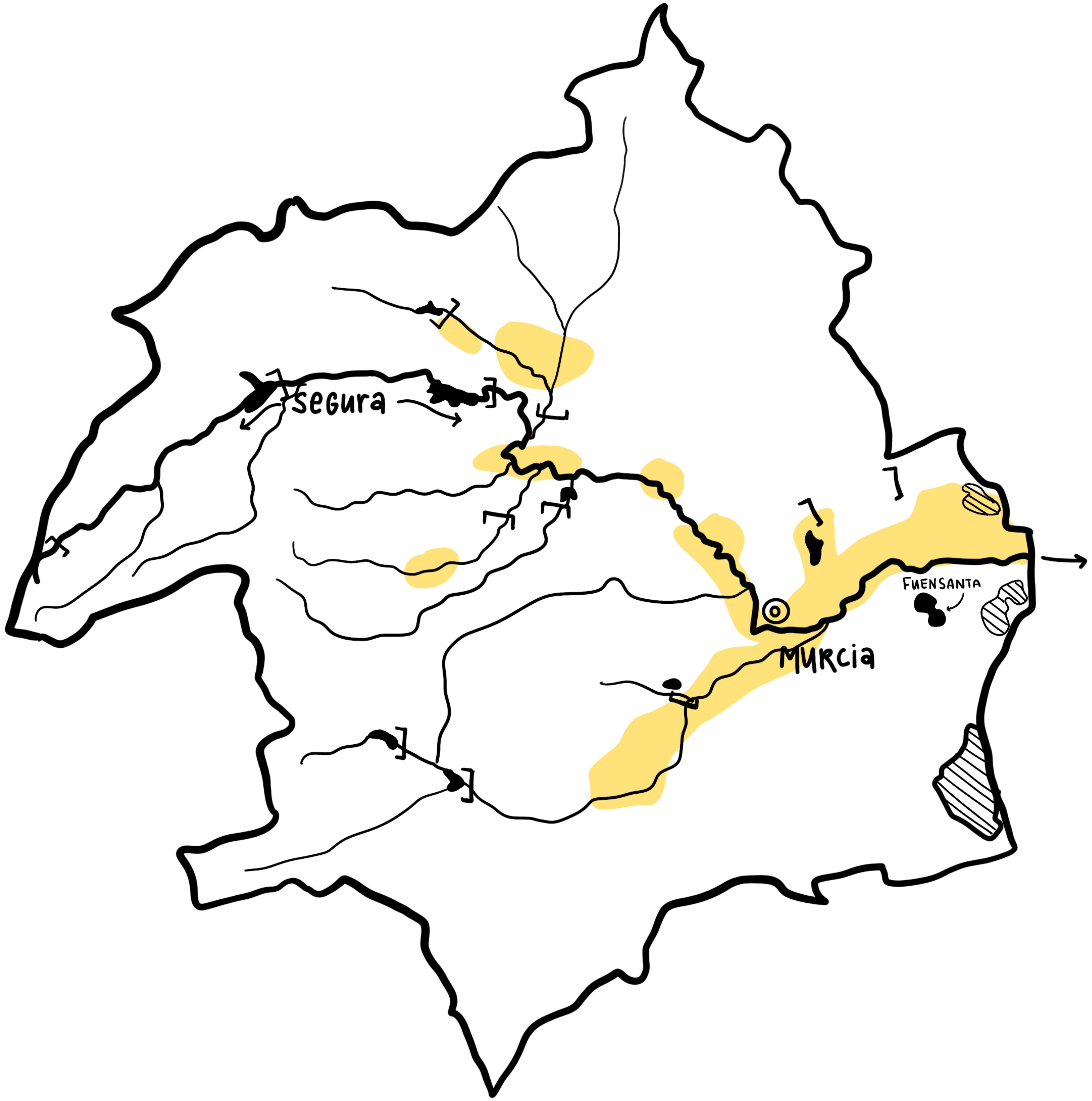
WATER POWER RIVALRIES (2004-2011)

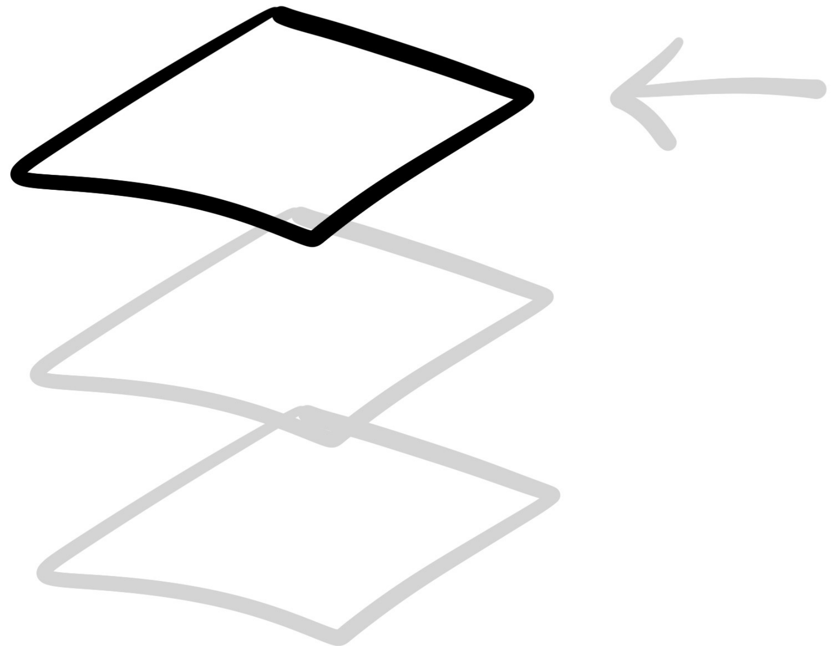
= POLITICAL BOUNDARIES
= SOCIALIST (PSOE)
= ALTERNATING NATIONALIST (CONSERVATIST) / LEFT COALITION (SOCIALIST-GREEN PARTY)
= CONSERVATIST (PP)
= COUNTRY BORDERS
X = REGIONS AGAINST TRANSFERS
! = REGIONS DEMANDING WATER

Figure 19. Socio-political conflict in Spain regarding the TST. Source: Made by author.

Figure 20. Source: Image by Fernando Alvarado, retrieved from (Bachiller, 2023).

TRADITIONAL IRRIGATION
1933 – 1952





IRRIGATION AREA

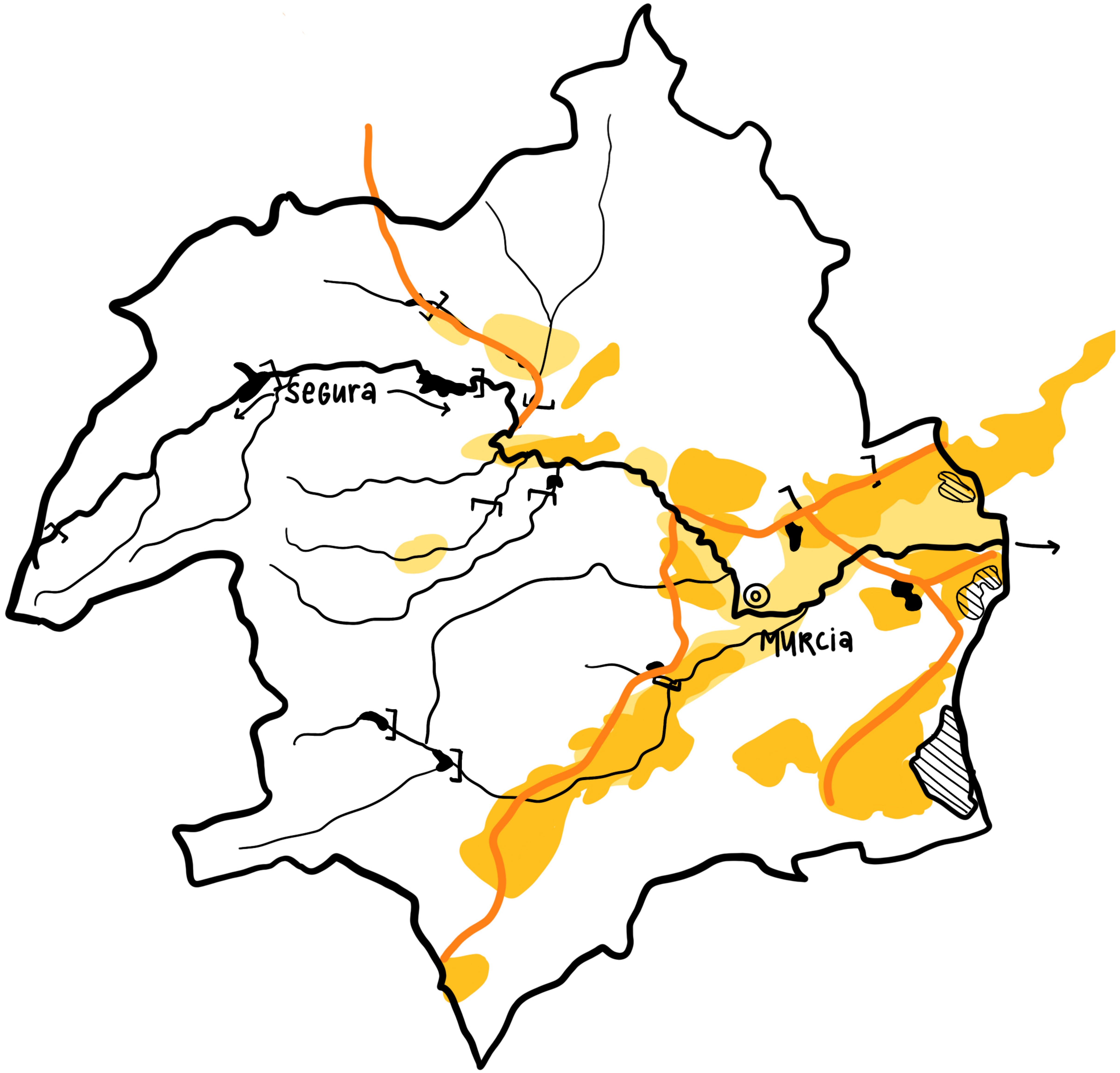
= TRADITIONAL IRRIGATED AREA

= OUTLINE SRB

= PROTECTED SALT MARSHES

Figure 21. Traditional Irrigation in the SRB. Source: Made by author, based on (Martínez-Alvarez et al, 2017)

TRANSFER IRRIGATION
1953 – 1979

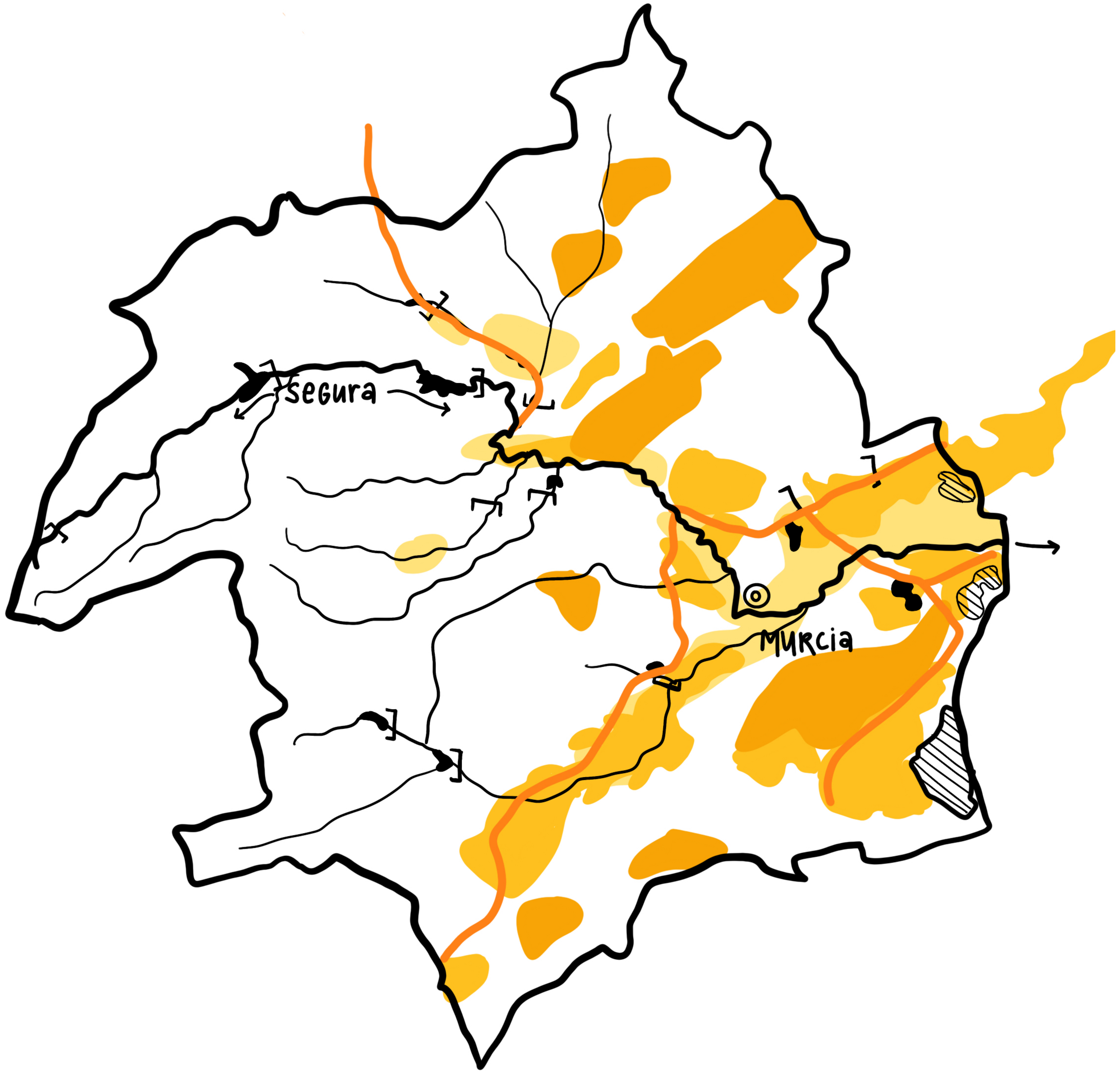


IRRIGATION AREA

= TRADITIONAL IRRIGATED AREA
= TST EXPANSION
= TST CANAL
= OUTLINE SRB
= PROTECTED SALT MARSHES

Figure 22. Irrigation agriculture after the promise of the TST. Source: Made by author, based on (Martínez-Alvarez et al, 2017)

GROUNDWATER IRRIGATION
1960 – 1980



IRRIGATION AREA

= TRADITIONAL IRRIGATED AREA
= TST EXPANSION
= GROUNDWATER PUMPING
= TST CANAL

= OUTLINE SRB

= PROTECTED SALT MARSHES

Figure 23. Irrigation agriculture after the development of groundwater extraction techniques. Source: Made by author, based on (Martínez-Alvarez et al, 2017)

DRIP IRRIGATION
1980 – 1990

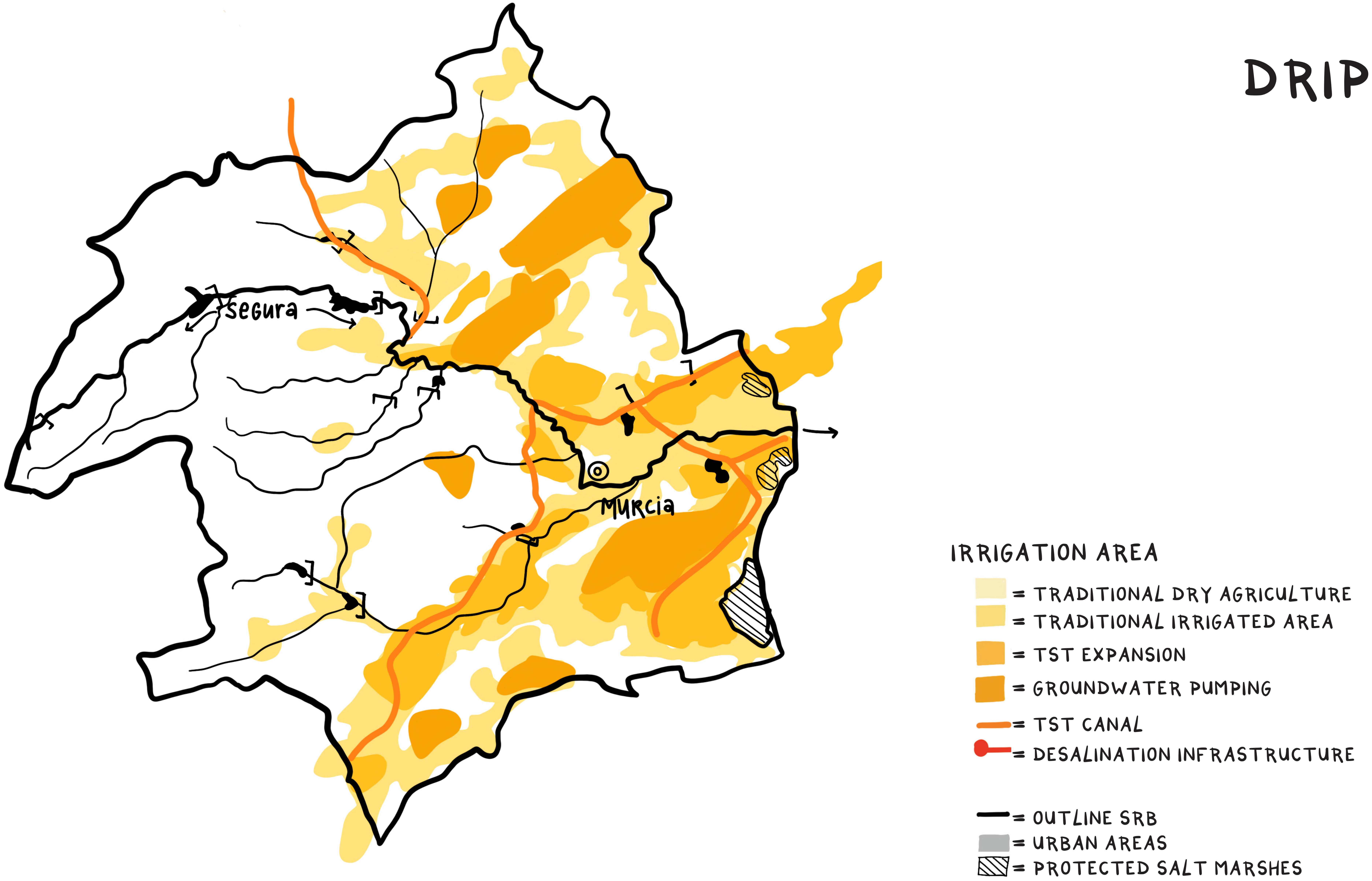
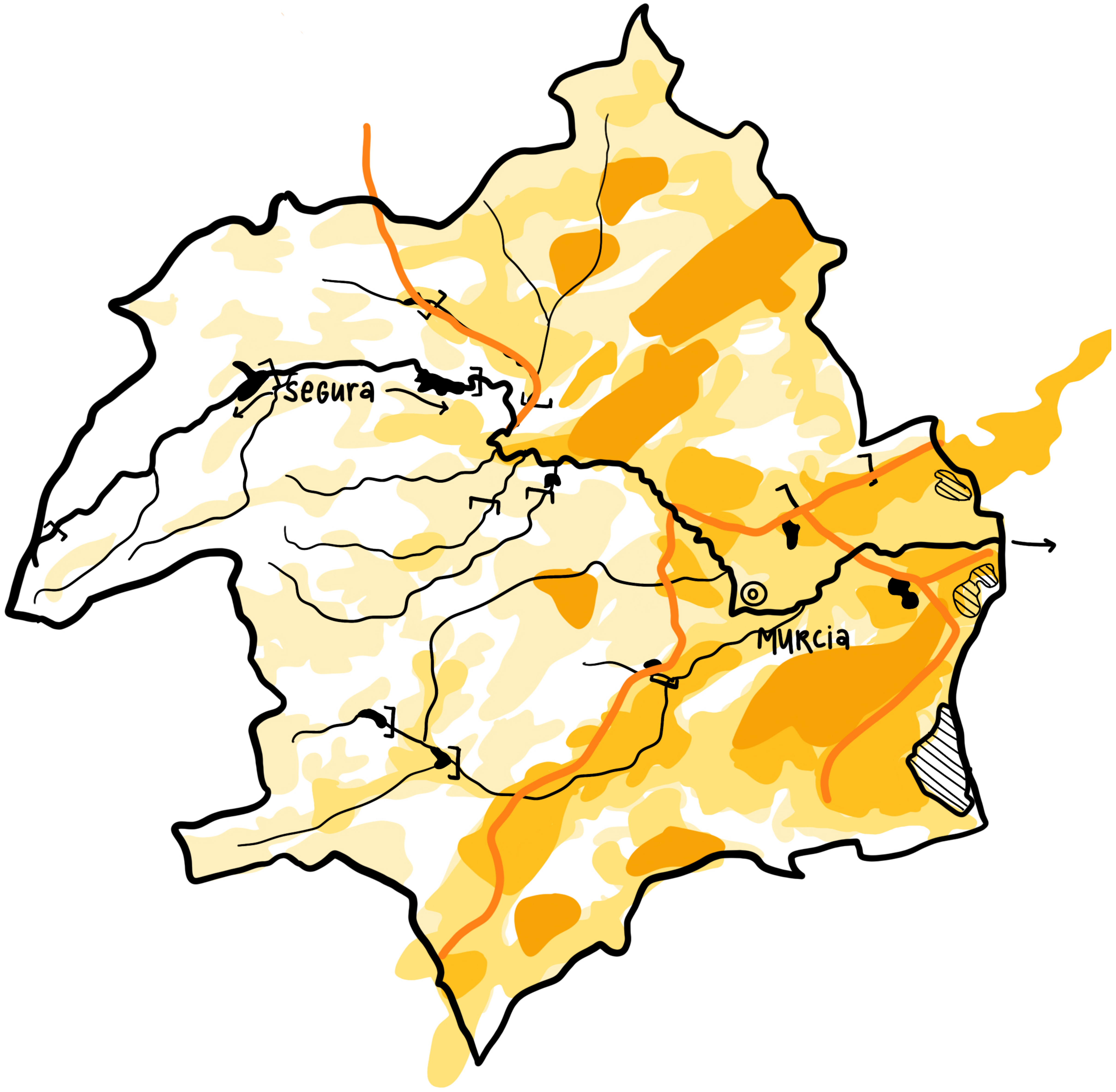


Figure 24. Total agricultural area. Source: Made by author, based on (Martínez-Alvarez et al, 2017)

TOTAL IRRIGATION
2007 – NOW



IRRIGATION AREA
= TRADITIONAL DRY AGRICULTURE
= TRADITIONAL IRRIGATED AREA
= TST EXPANSION
= GROUNDWATER PUMPING
= TST CANAL
= DESALINATION INFRASTRUCTURE

= OUTLINE SRB
= URBAN AREAS
= PROTECTED SALT MARSHES

Figure 25. Location of the main desalination plants in the region. Source: Made by author, based on (Martínez-Alvarez et al., 2017).

DESALINATION IRRIGATION
2007 – 2011

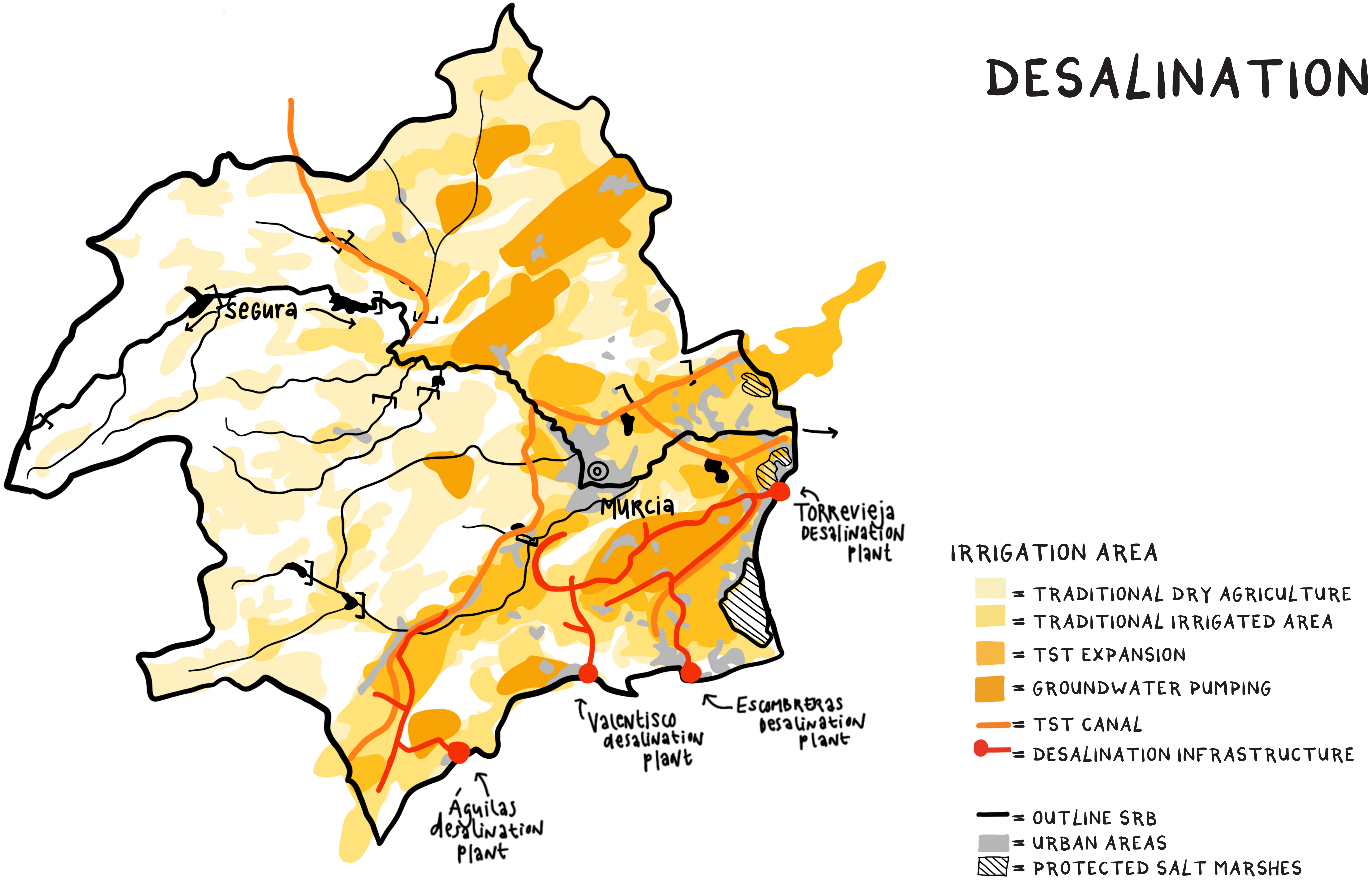
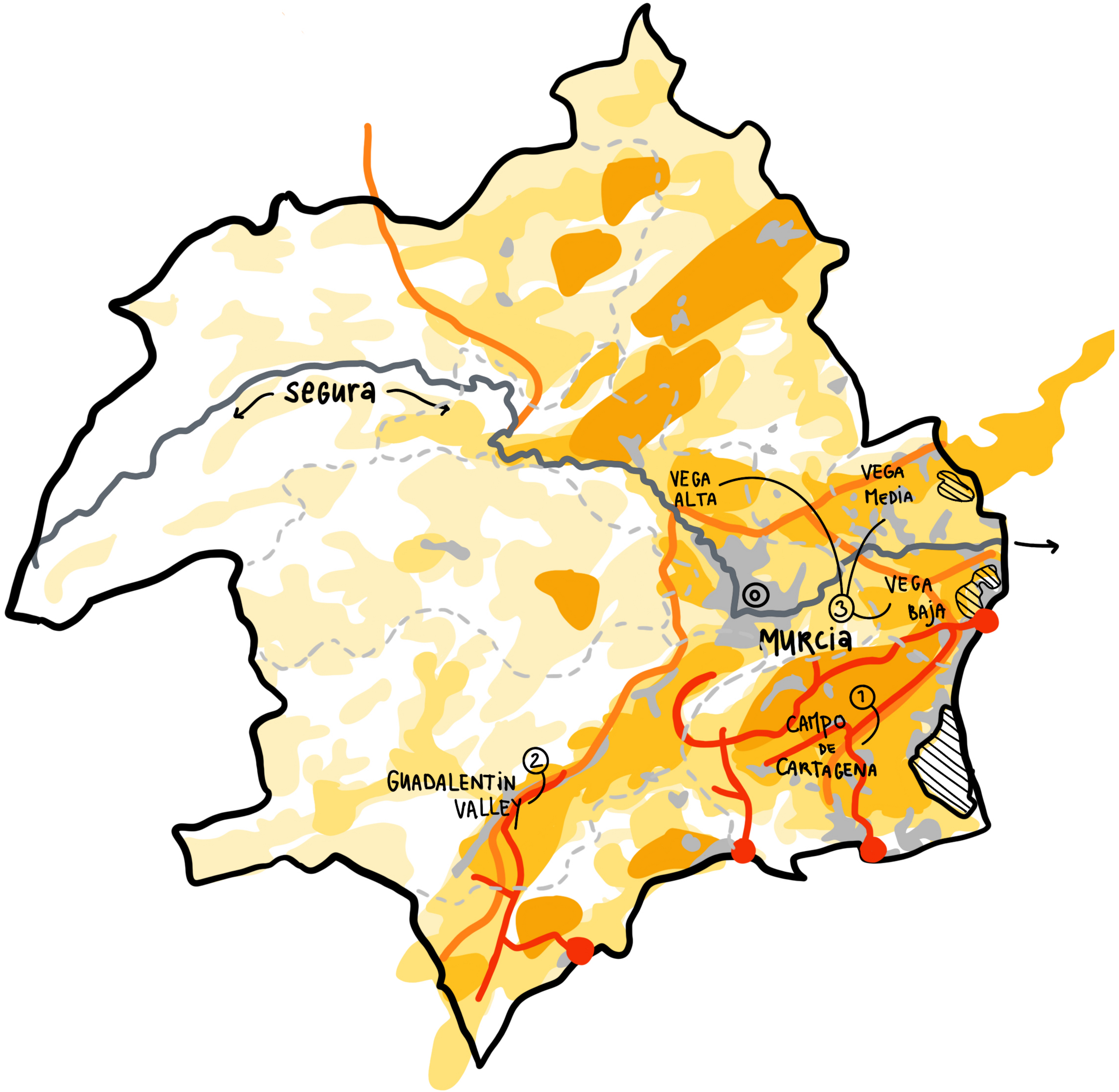


Figure 26. Location of the main desalination plants in the region. Source: Made by author, based on (Martínez-Alvarez et al., 2017).

MAIN IRRIGATION
1953 – NOW



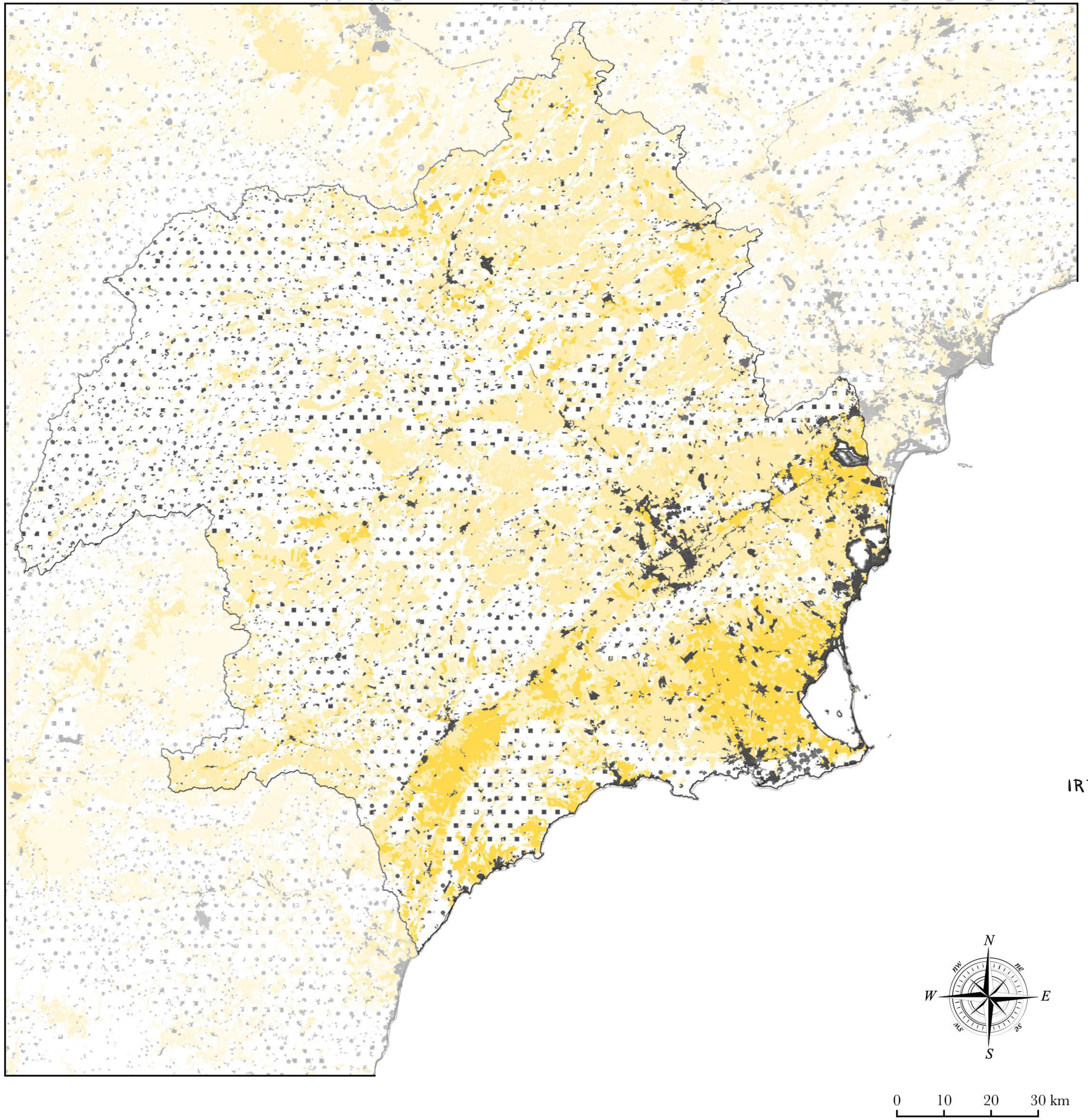
IRRIGATION AREA

- = TRADITIONAL DRY AGRICULTURE
- = TRADITIONAL IRRIGATED AREA
- = TST EXPANSION
- = GROUNDWATER PUMPING
- = TST CANAL
- = DESALINATION INFRASTRUCTURE

- = OUTLINE SRB
- = URBAN AREAS
- = PROTECTED SALT MARSHES

Figure 27. Location of the main irrigated areas. Source: Made by author, based on (Martínez-Alvarez et al., 2017).

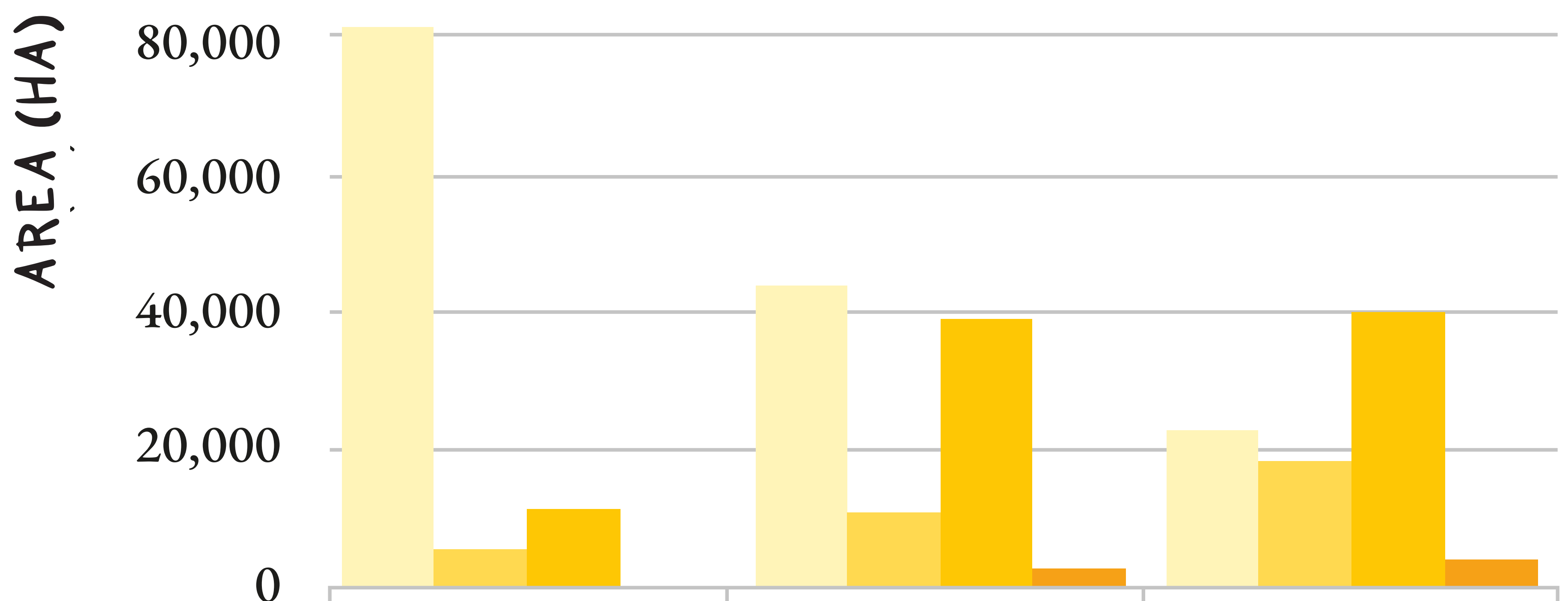
AGRICULTURE TREND



Corine Land Cover 2018 vector
- Urban area
- 212: Permanently irrigated land
- 241: Annual crops associated with permanent crops
- 231: Pastures
- 221: Vineyards
- 222: Fruit trees and berry plantations
- 242: Complex cultivation patterns
- 223: Olive groves
- 211: Non-irrigated arable land
- 244: Agro-forestry areas
- 243: Land principally occupied by agriculture, wil
- 323: Sclerophyllous vegetation

Figure 28. Agriculture intensity. Source: made by author, based on (FutureWater, z.d.).

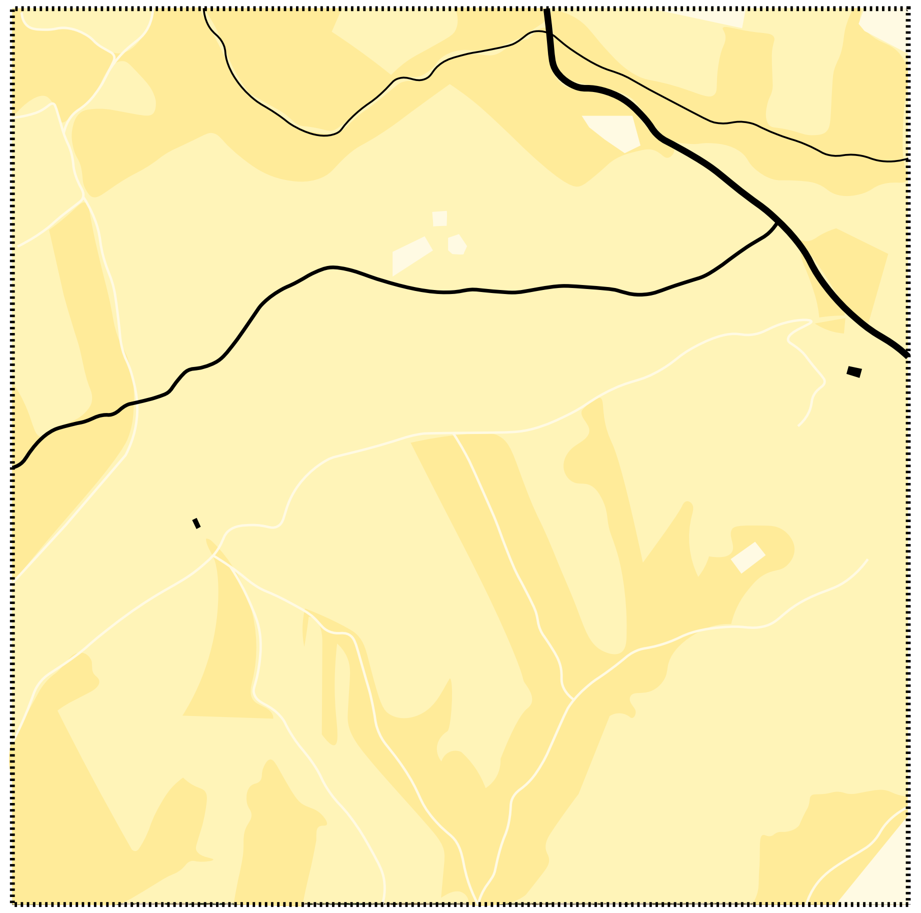
CAMPO DE CARTAGENA GREENHOUSE EVOLUTION



	1977	2000	2020
RAINFED TREE CROPS	80,820	43,612	22,432
IRRIGATED TREE CROPS	5,880	10,912	18,156
IRRIGATED HORTICULTURE	11,520	39,588	39,715
GREENHOUSES	64	2,260	3,924

Figure 29. Graph of agriculture transition towards more intensive water use systems. Source: made by author, based on (FutureWater, z.d.).

Dry Agriculture



scale 1:10.000

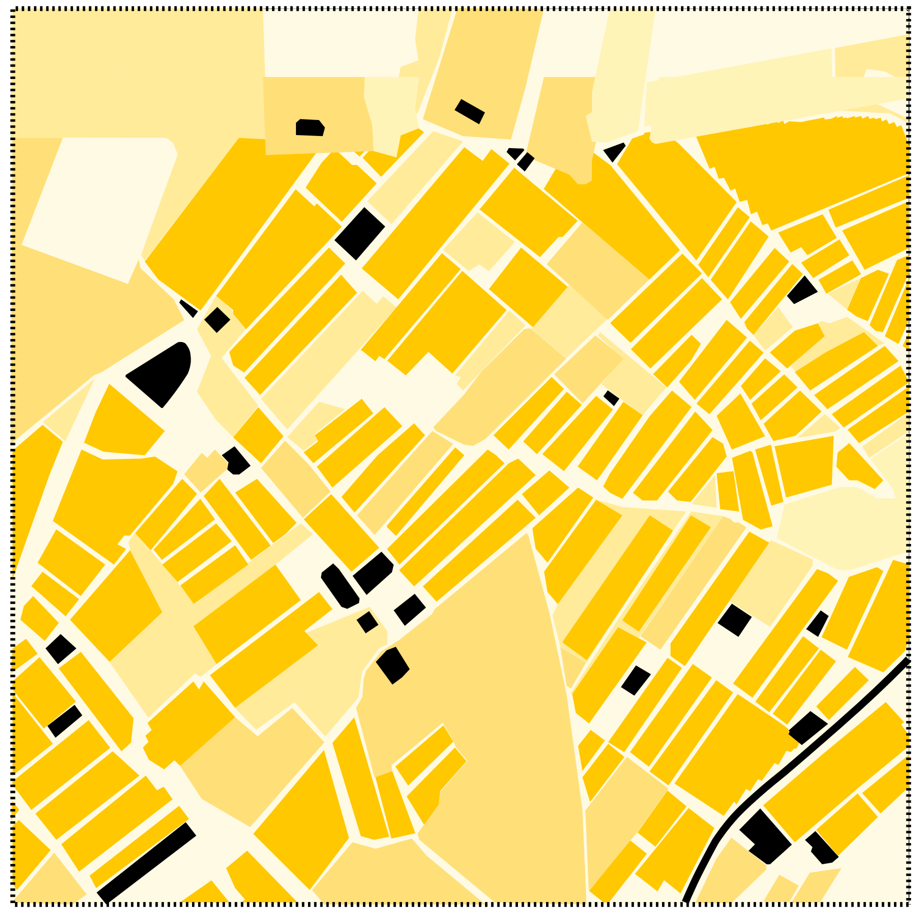
- = Waterbody
- = Natural area - Grassland
- = Non-irrigated agricultural land - Rainfed fruit trees & Agroforestry
- = built space / road / urban

Intensive Irrigation Agriculture

scale 1:10.000

- = Waterbody
- = Greenhouses - permanently irrigated land
- = Irrigated agriculture land - Crops
- = Pastures & Grassland
- = Non-irrigated agricultural land - Rainfed fruit trees & Agroforestry
- = built space / road / urban

Greenhouse Agriculture - permanently irrigated



scale 1:10.000

- = Waterbody
- = Greenhouses - permanently irrigated land
- = Irrigated agriculture land - Crops
- = Pastures & Grassland
- = Non-irrigated agricultural land - Rainfed fruit trees & Agroforestry
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EXPORT PRODUCTION

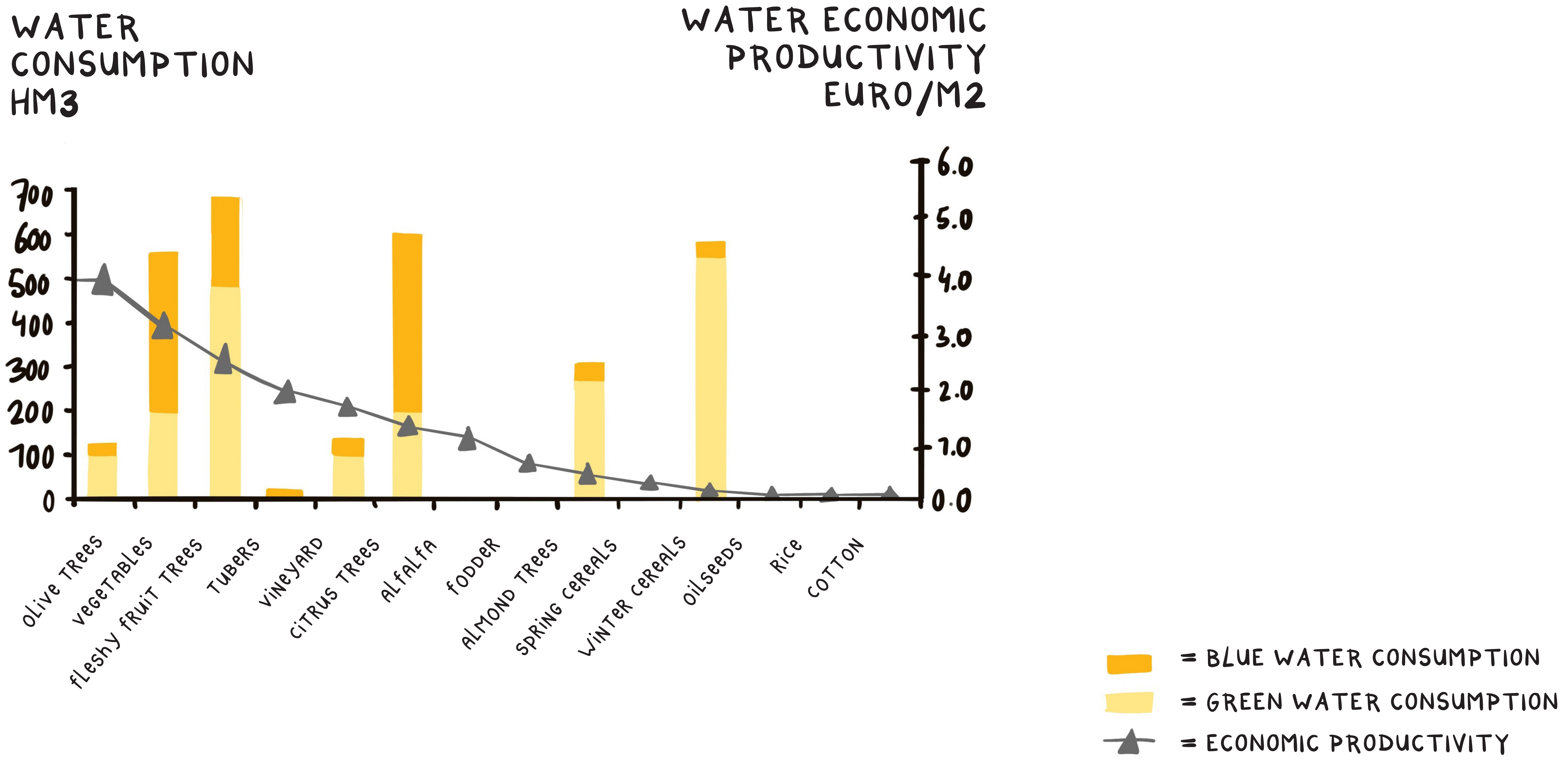


Figure 30. Blue and green water consumption and blue water economic productivity in the SRB. Source: Aldaya et al (2019), based on CHS (2015) and data from the Government of Spain and the green water footprint (Aldaya et al., 2017).

Figure 32. Image of the plastic foil landscapes of the quilted agriculture of Campo de Cartagena, near Cartagena city. Source: Made by author.

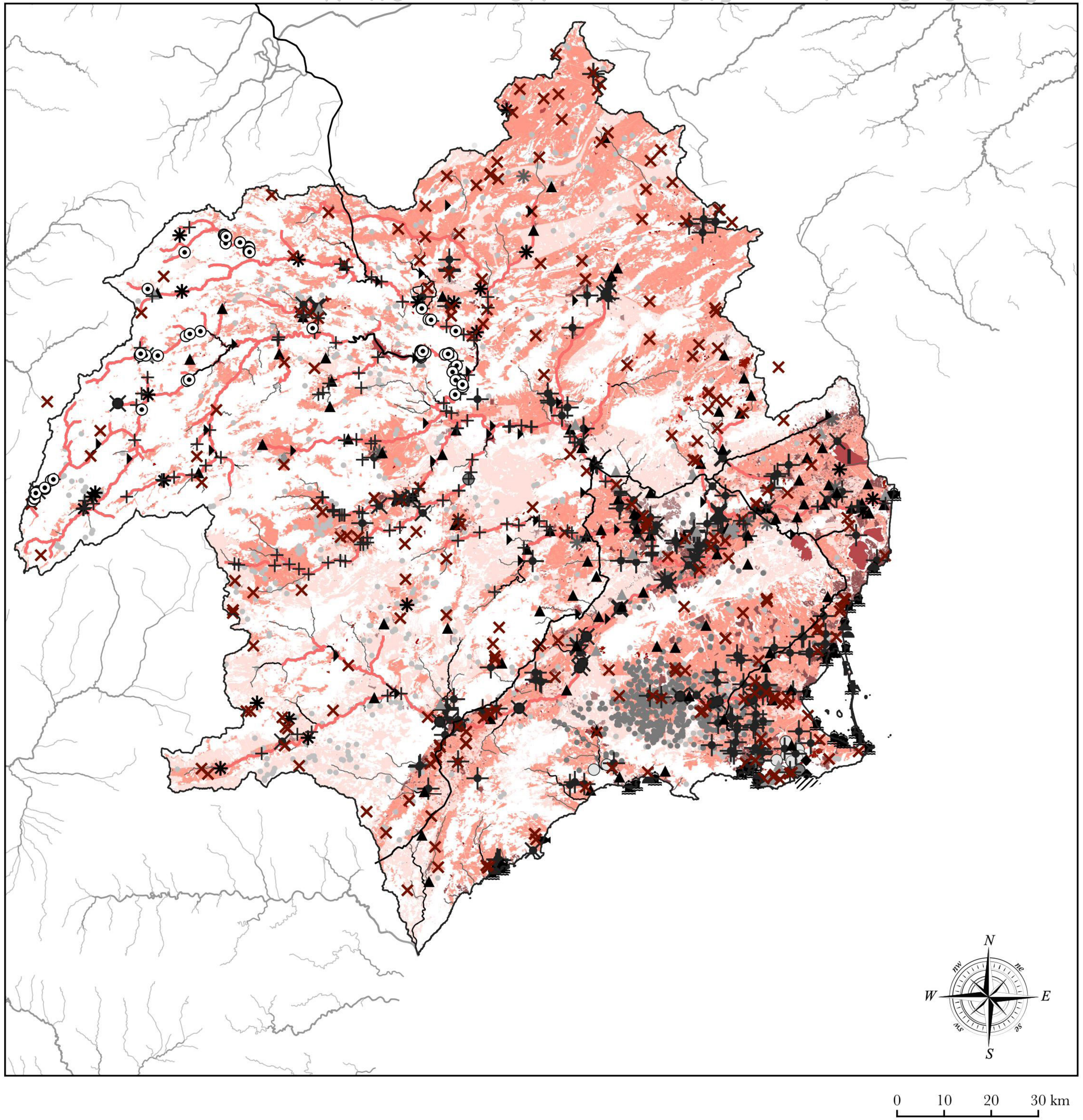
Figure 33. Image of the export industry in the harbour of Campo de Cartagena, in Cartagena city. Source: Made by author.

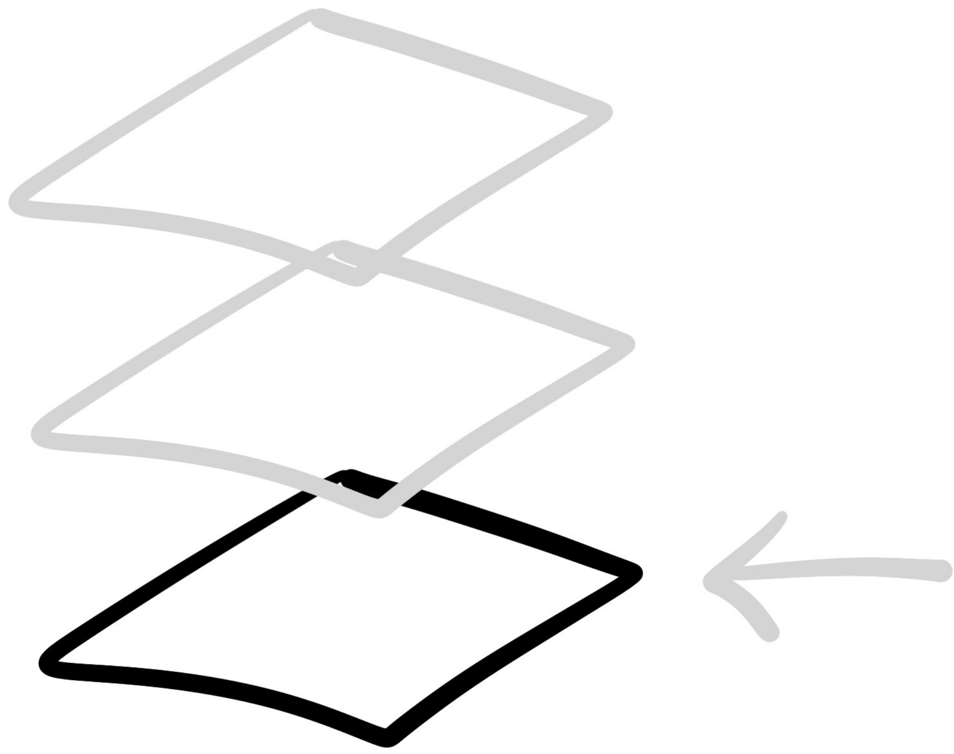
Figure 34. Image of an empty container ship entering the export harbour of Campo de Cartagena, in Cartagena city. Source: Made by author.

Figure 35. Image of the energy landscapes in the industrial area of the Cartagena food export harbour. Source: Made by author.

Figure 36. Image of the energy landscapes in the industrial area of the Cartagena food export harbour. Source: Made by author.

POLLUTING EFFECTS





SRB outline
TST
Pollution of natural coastal areas - agricultural use

A. Surface water bodies - Pressures

Point pollution
- Alteration of water body connections
- Dams
- Forest exploitations
- Groundwater extractions
- Nitrate detections
- Authorised discharge points
- authorised urban discharges
- Specific non authorised discharge points
- non-authorised urban discharges
- Other discharges - most important desalination facilities
- Marine waste
- Ports
- Underground landfills
- Mass landfills
- Historical contamination
- Debris dumps
- Mining debris dumps
- Dumping areas of controlled and uncontrolled landfills

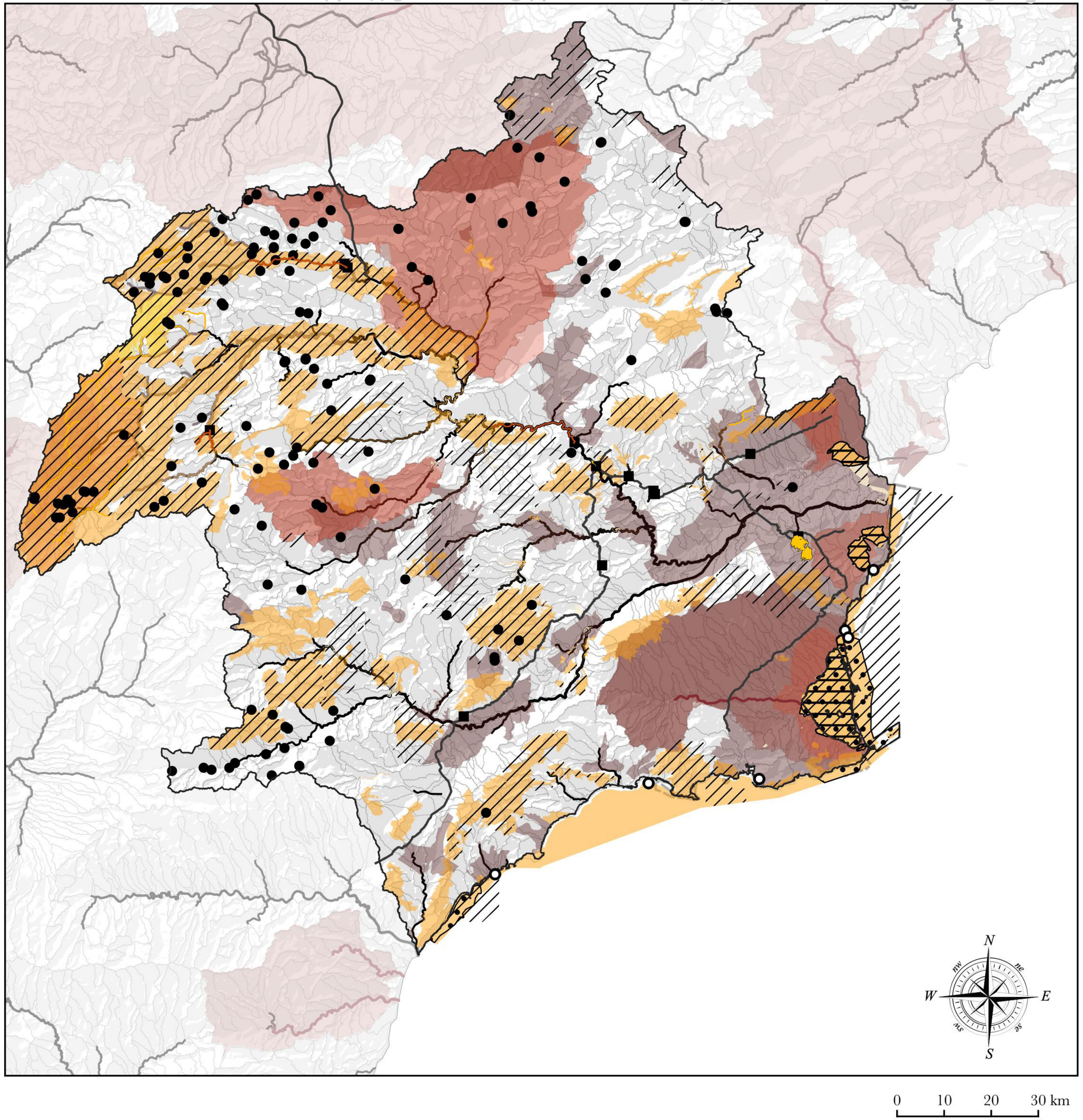
River pollution
- Natural river - Agricultural use
- Natural river - Urban runoff

B. Groundwater bodies - Pressures

1. Diffuse pollution
- Livestock farms - pigs
- Livestock farms - other
- lake pollution
- abandoned brownfields
- Mining
- Urban discharge
- Land use - urban runoff
- Agriculture
- Land use - Agriculture

Figure 37. Diffuse and point pollution in the SRB. Source: Made by author, based on data from CHS (2025) .

VULNERABLE AREAS



Water Supply
- Protected reservoirs for water supply
- Protected rivers for water suppy
- Surface water abstraction points
- Groundwater abstraction points
- Coastal water abstraction points

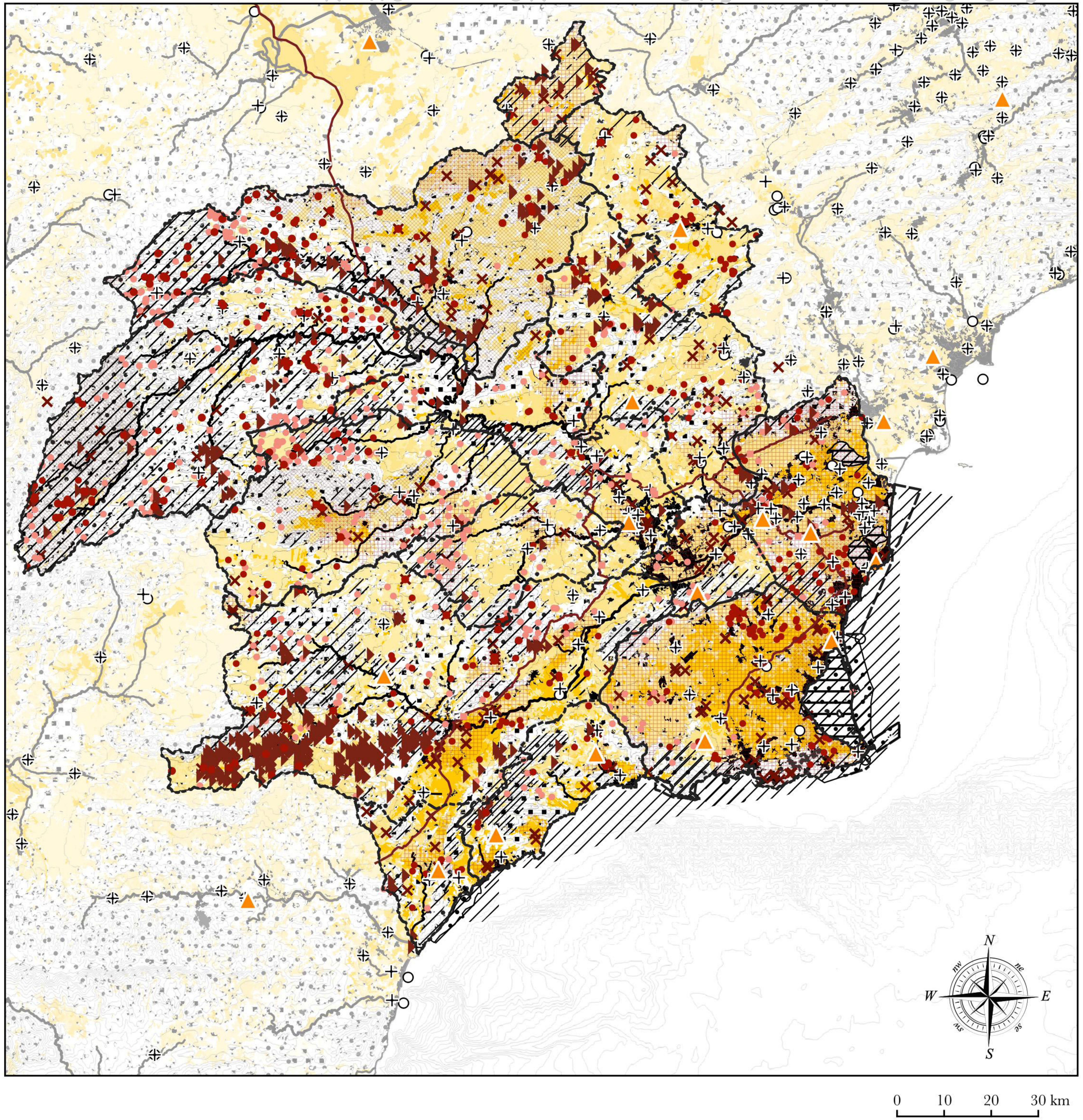
Protected Habitats
- RAMSAR - internationally protected wetlands
- Special protected areas
- ZEPA - special protection areas for birds
- Wetlands protected by Spain
- Groundwater protection
- SCI - LIZEC - special conservation zones related to water
- Fluvial natural reserves - riverine protected areas

Ecologically vulnerable areas
- Vulnerable zones
- Sensitive zones
- Sensitive areas - water catchment areas
- Sensitive areas - drainage basins
- Sensitive areas - rivers

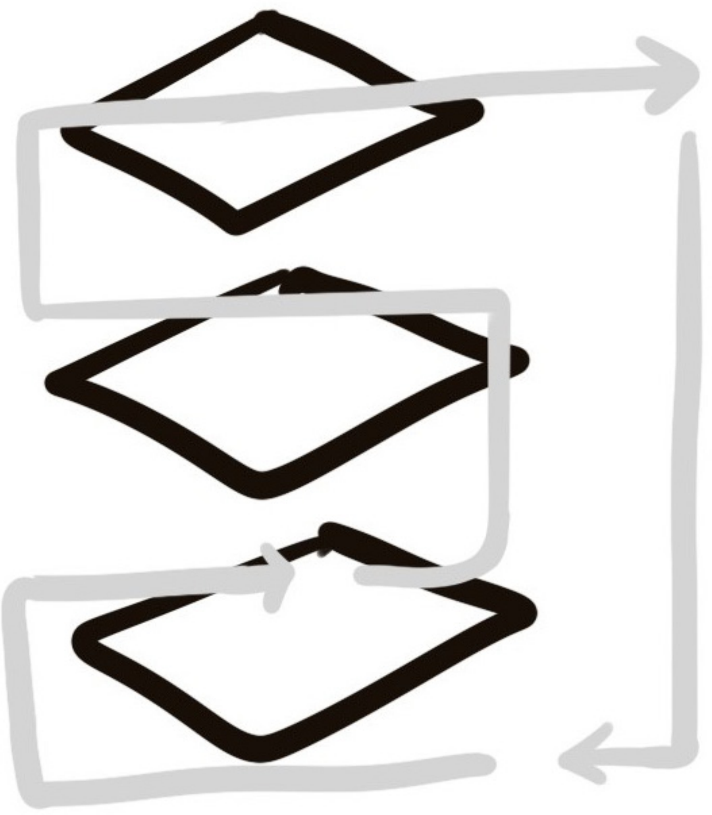
Protected areas of economic interest
- Shellfish production
- Fishing interest
- Trout waters Castilla La Mancha

Base map
- Inland water
- Drainage network
- SRB outline
- TST

Figure 38. Protected and vulnerable areas and water abstractions. Source: Made by author, based on data from CHS (2025) .



SYSTEM SYNTHESIS



SRB outline

Corine Land Cover 2018 vector

- Urban area
- 212: Permanently irrigated land
- 241: Annual crops associated with permanent crops
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- 213: Rice fields
- 221: Vineyards
- 222: Fruit trees and berry plantations
- 242: Complex cultivation patterns
- 223: Olive groves
- 211: Non-irrigated arable land
- 244: Agro-forestry areas
- 243: Land principally occupied by agriculture
- 311, 312,313,314: natural area and forest

- Campo de Cartagena sub-basin boundary
- groundwater protection areas
- extra specially protected areas
- RAMSAR - international protected wetlands
- protected habitats - SCI - special conservation zones related to water
- protected habitats - special protection areas for birds
- economically significant - trout waters Castilla la Mancha
- economically significant - fishing interest
- economically significant - shellfish production
- monitoring stations affected by nitrates
- sensitive area - drainage basins
- sensitive areas ecology
- Vulnerable areas
- Discharge points wastewater treatment
- Wastewater treatment plants
- Desalination plants
- Dams
- Tajo-Segura canal
- surface water abstraction points
- Water springs
- groundwater abstraction points
- Wells water extraction

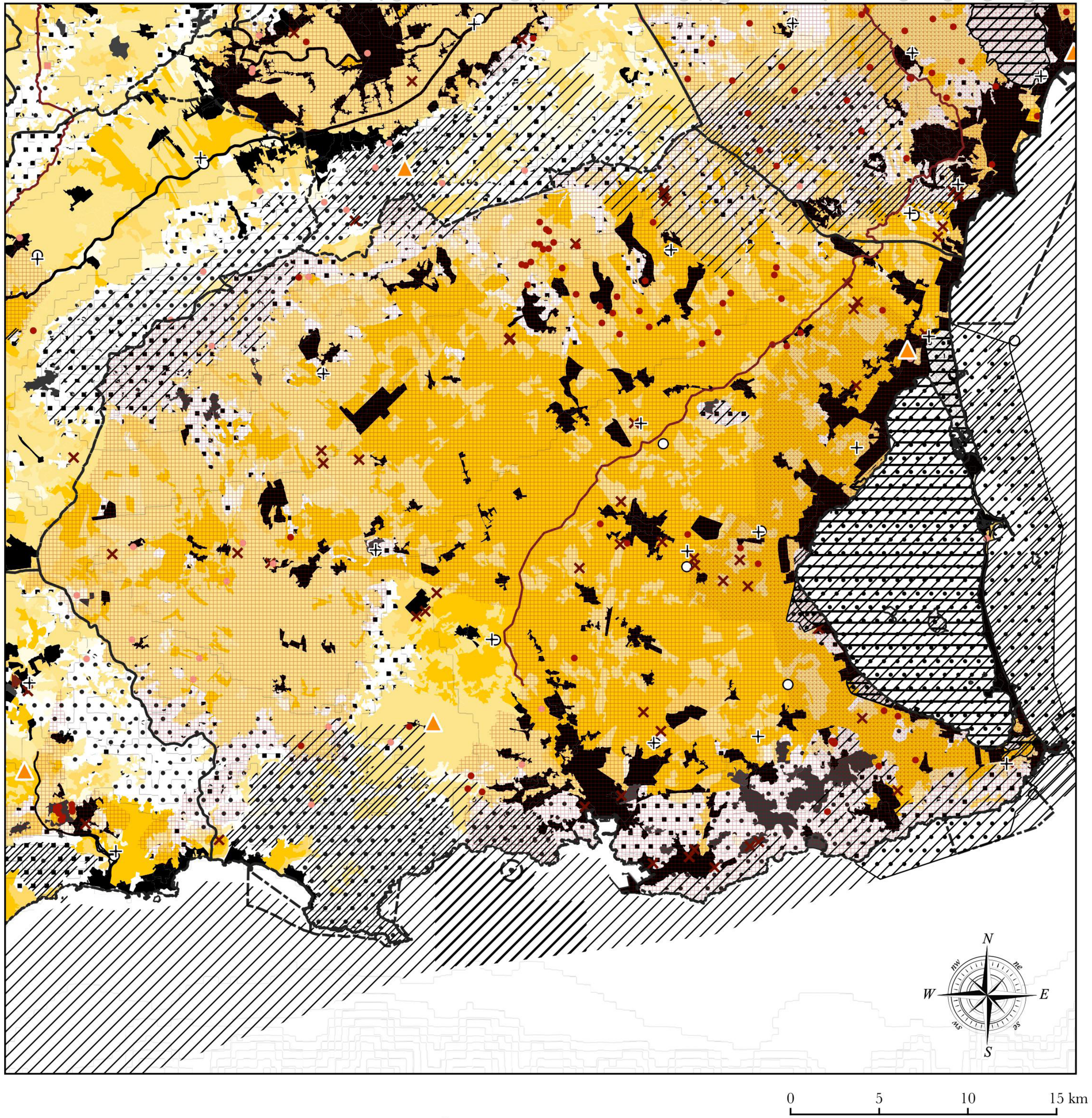
Figure 39. Cumulative map of the layered analysis on the full basin scale. Source: made by author.

DESIGN LOCATION

CAMPO DE CARTAGENA

...

- vulnerable area
- intensive monocultures
- protected wetlands
- economically significant
- drainage of the basin



SRB outline

Corine Land Cover 2018 vector
- Urban area
- 212: Permanently irrigated land
- 241: Annual crops associated with permanent crops
- 231: Pastures
- 213: Rice fields
- 221: Vineyards
- 222: Fruit trees and berry plantations
- 242: Complex cultivation patterns
- 223: Olive groves
- 211: Non-irrigated arable land
- 244: Agro-forestry areas
- 243: Land principally occupied by agriculture
- 311, 312,313,314: natural area and forest

- Campo de Cartagena sub-basin boundary
- groundwater protection areas
- extra specially protected areas
- RAMSAR - international protected wetlands
- protected habitats - SCI - special conservation zones related to water
- protected habitats - special protection areas for birds
- economically significant - trout waters Castilla la Mancha
- economically significant - fishing interest
- economically significant - shellfish production
- monitoring stations affected by nitrates
- sensitive area - drainage basins
- sensitive areas ecology
- Vulnerable areas
- Discharge points wastewater treatment
- Wastewater treatment plants
- Desalination plants
- Dams
- Tajo-Segura canal
- surface water abstraction points
- Water springs
- groundwater abstraction points
- Wells water extraction

Figure 40. Synthesis of the layered analysis on the sub-basin scale. Source: made by author, based on data from (CHS, 2025).

Figure 41. Image of the desalination infrastructures in the polluted protected saline wetlands. Source: Made by author.

Figure 42. (Marín et al., 2015).

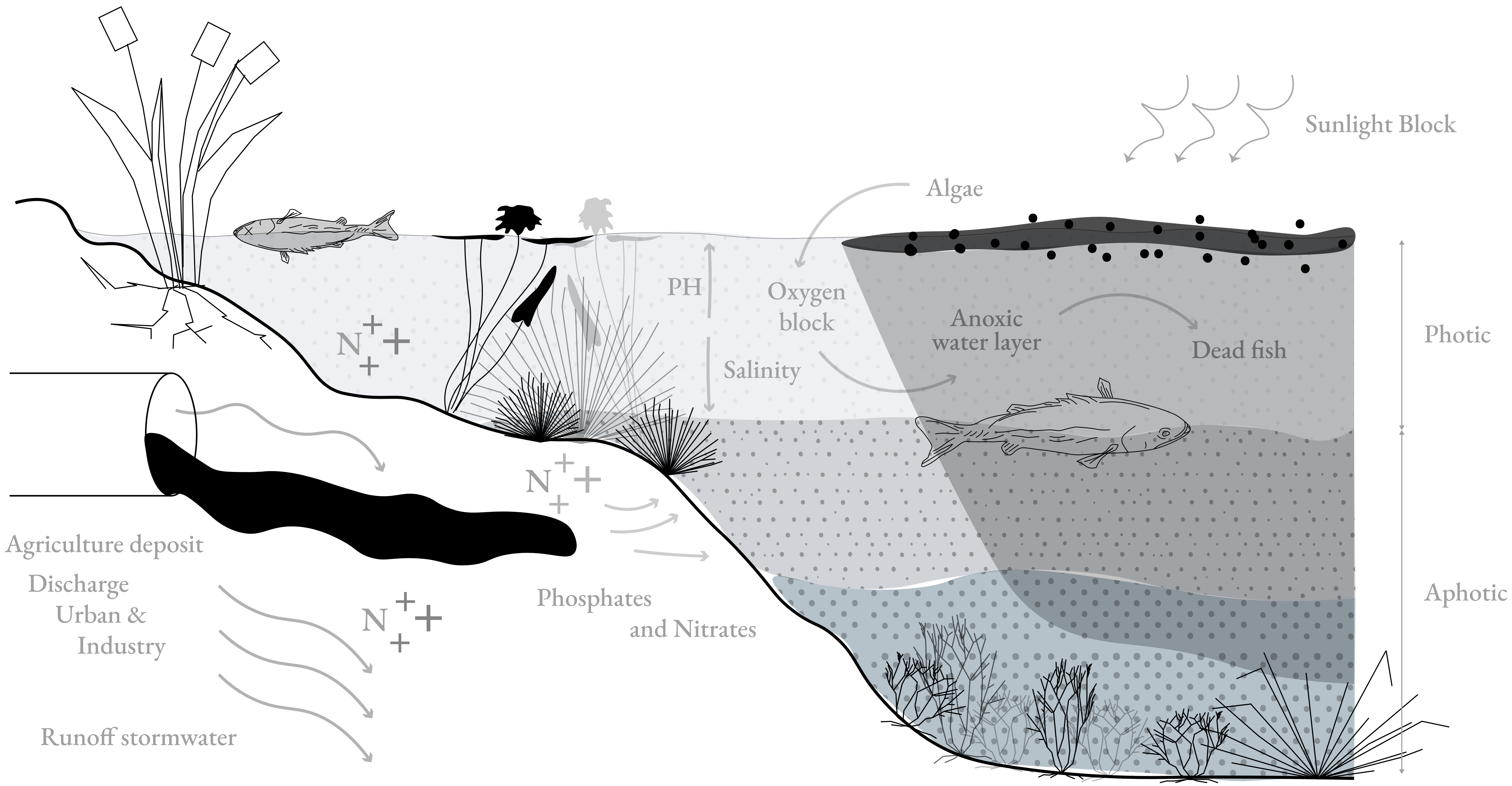
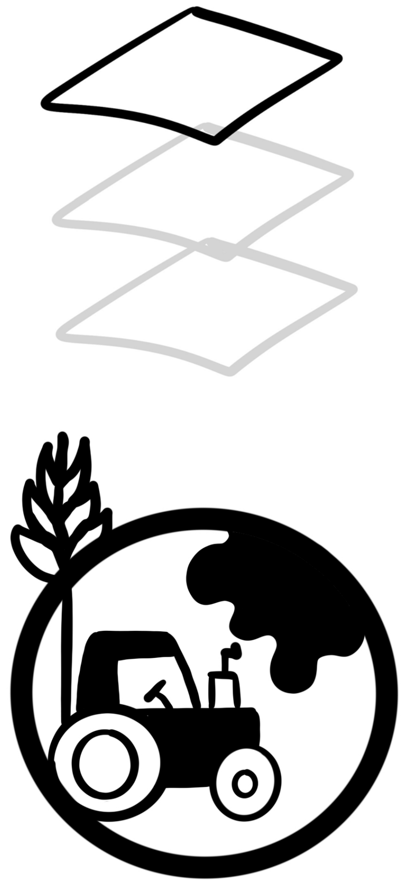


Figure 43. Section of the pollution in Mar Menor. Source: Made by author.

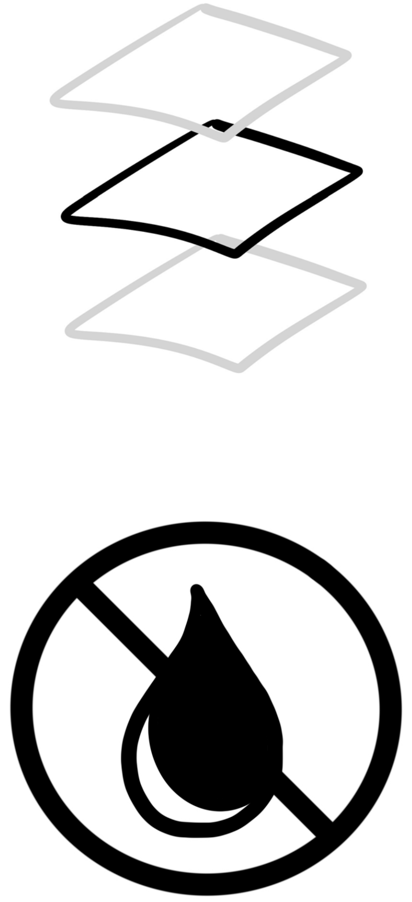
Figure 44. Polluted water of Mar Menor. Source: made by author.

3 SYSTEMIC LAYERS



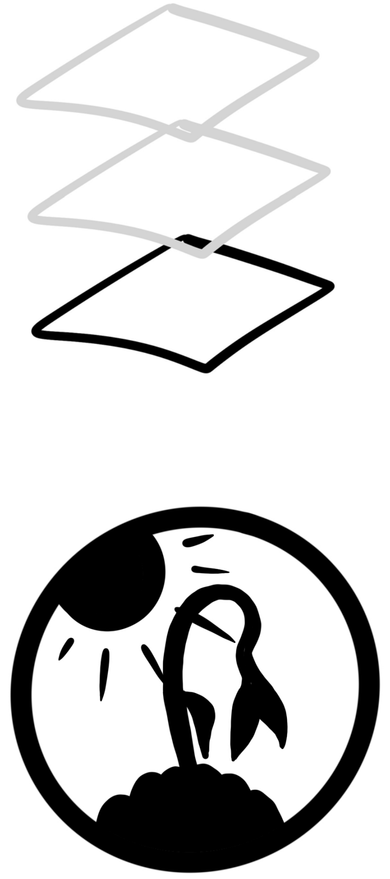
UNSUSTAINABLE FOOD PRODUCTION

- uncontrolled irrigation expansion
- technical solutions lead to Jevons paradox
- infrastructural lock-ins
- water intensive monocultures
- unfair profit distribution
- high fossil fuel usage



POOR WATER MANAGEMENT

- structural supply shortage
- dependent on interbasin transfers
- outdated infrastructures
- virtual water export



NEGLECTED NATURE

- polluted waters
- desertification
- groundwater salinisation
- declining biodiversity

3 SYSTEMIC TRANSITIONS

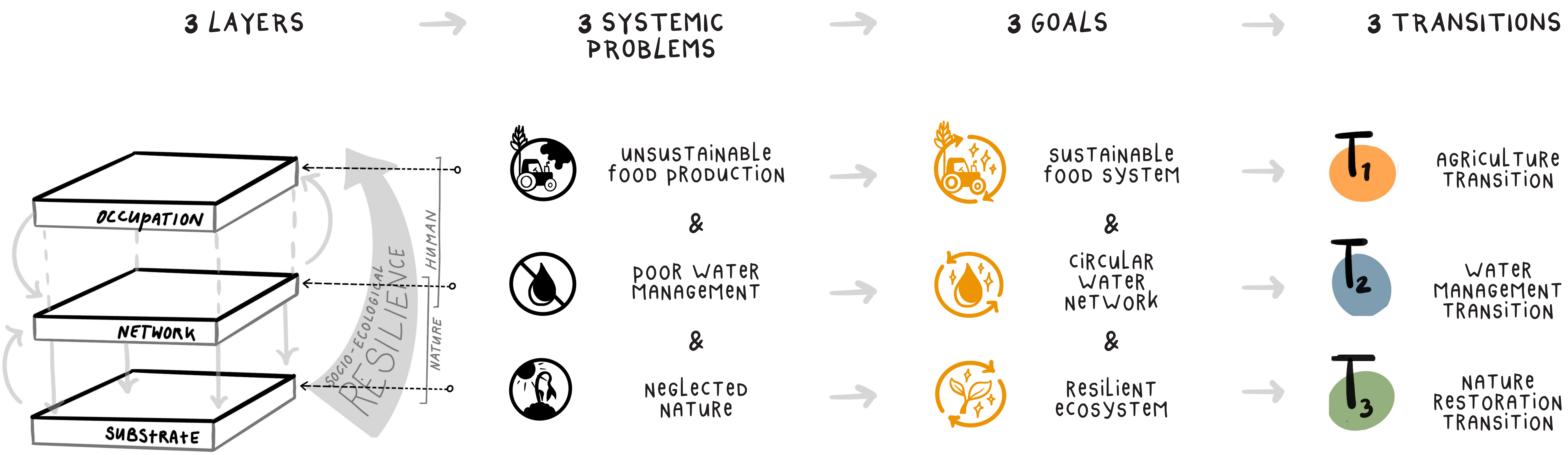
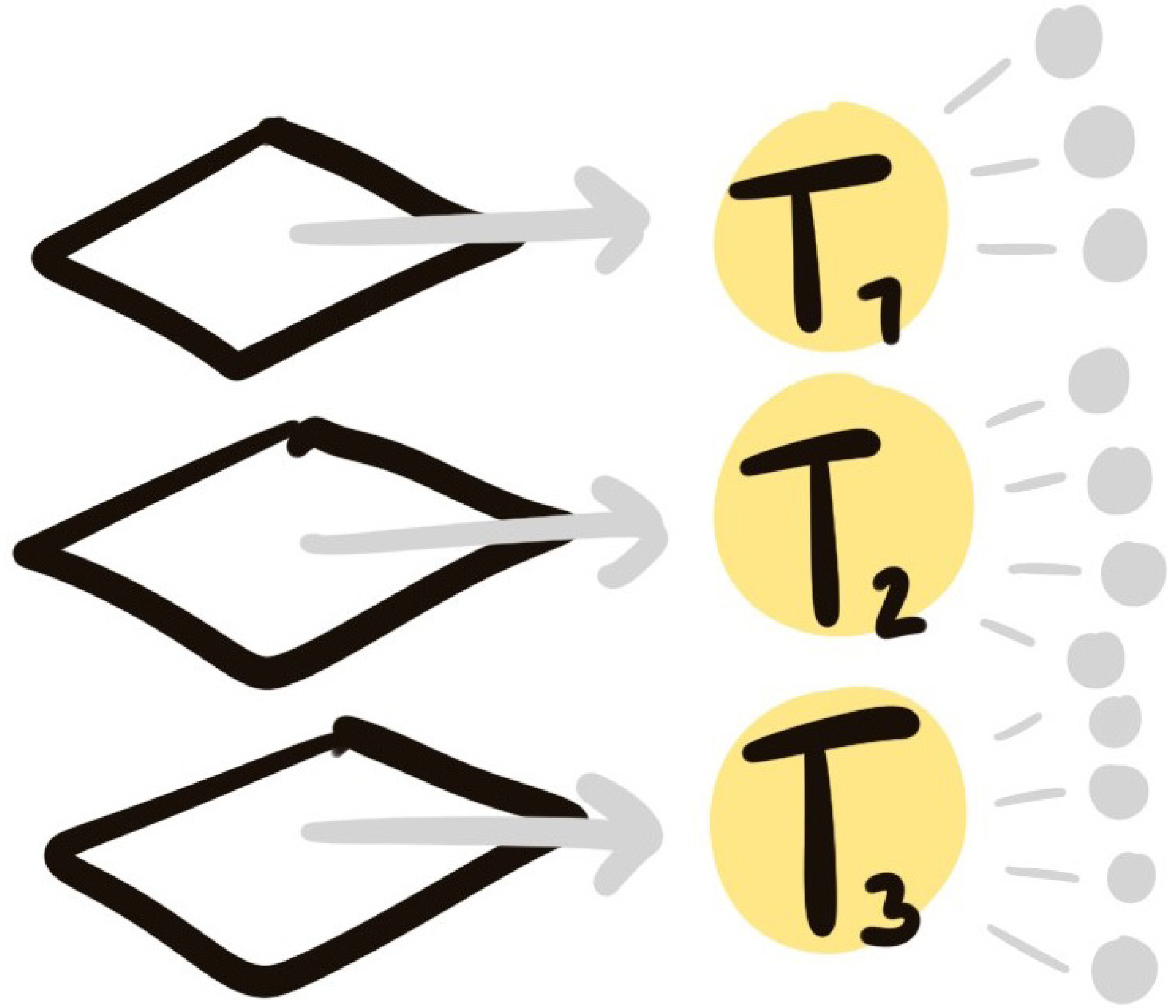


Figure 45. Conclusion of the analysis of the systemic layers

VISION



OBJECTIVES

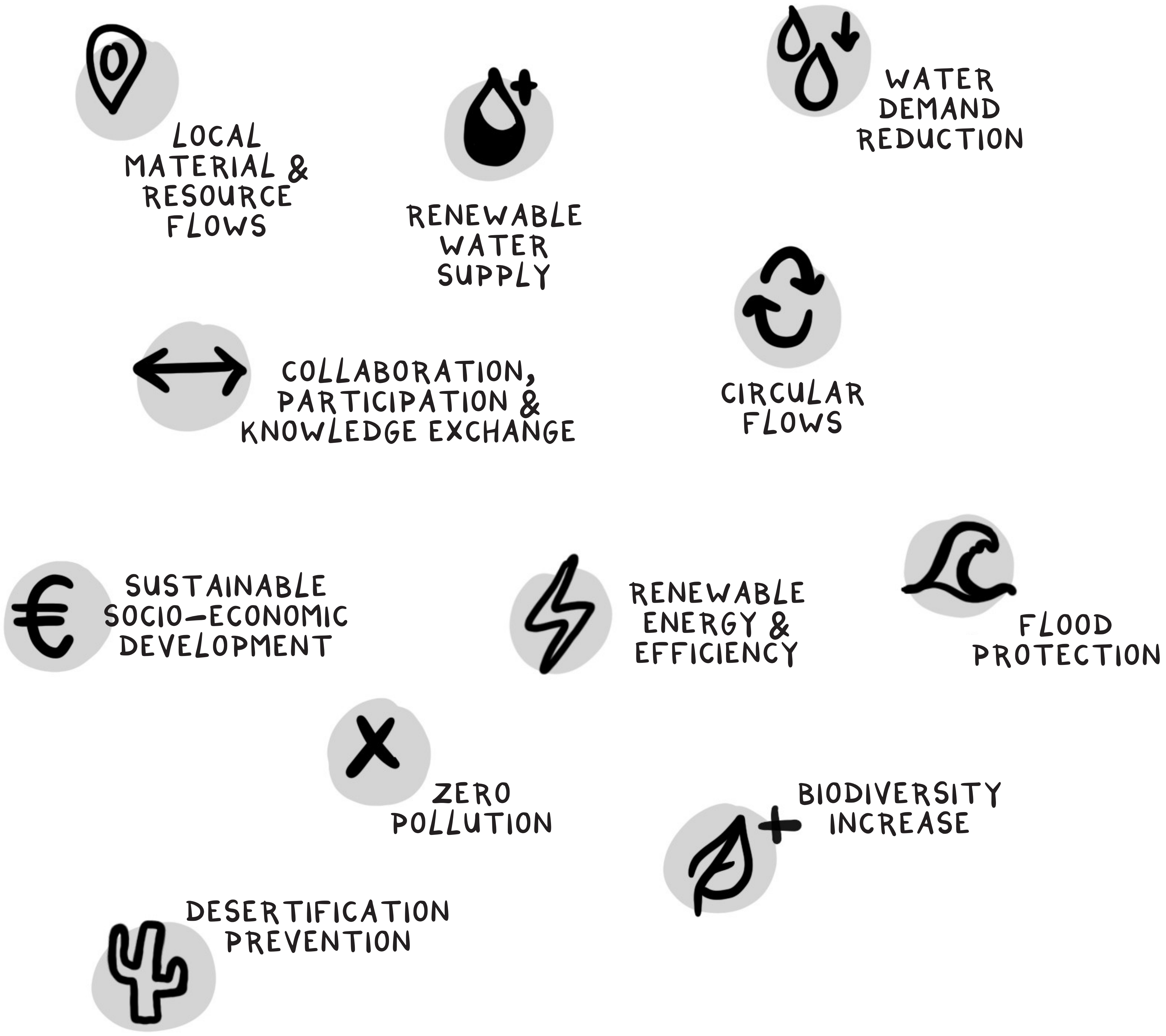


Figure 46. Design principles for the transition of the water system in the region. Source: made by author.

GLOBAL TRENDS & FRAMEWORKS

G_{1a} GLOBAL MARKET FOR ORGANIC AGRICULTURE

G_{1b} DECENTRALISATION OF FOOD PRODUCTION

G_1 RETHINKING PRODUCTION LANDSCAPES

G_2 WATER SCARCITY AWARENESS

G_3 NATURE BASED SOLUTIONS

G_4 TECHNOLOGICAL DEVELOPMENT

political focus directions (R)

R_1 ORGANIC FOOD PRODUCTION

R_{1A} CREATE A MARKET FOR ORGANIC PRODUCTS

R_{1B} IMPLEMENT REGULATIONS FOR ORGANIC FOOD PRODUCTION

R_{1C} IMPLEMENT SUBSIDIES FOR ORGANIC FOOD PRODUCTION

POLITICAL FOCUS & POLICIES

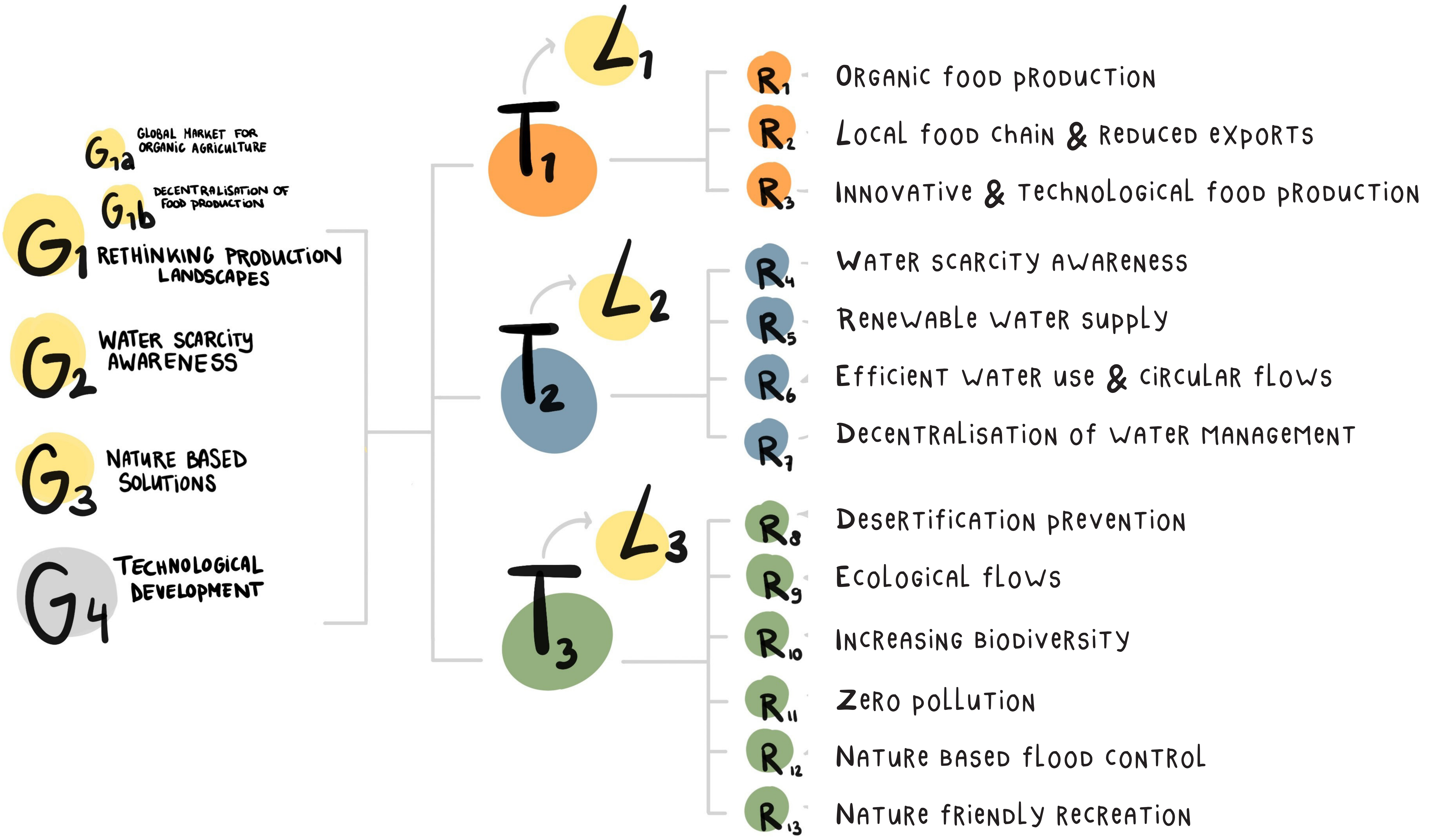


Figure 47. Start of a decision tree in symbiotic design of the water system. Source: made by author.

STAKEHOLDERS

A = AGRICULTURE SECTOR

- LOCAL FARMERS
- BIG PRODUCTION COMPANIES
- EXPORT INDUSTRY
- PACKAGING INDUSTRY
- TRANSPORT INDUSTRY
- IRRIGATION COMMUNITIES

N = NATURE SECTOR

- NGO
- ACTIVISTS
- LOCAL COMMUNITIES
- LEGAL COURT
- NATURE CONSERVATORIES

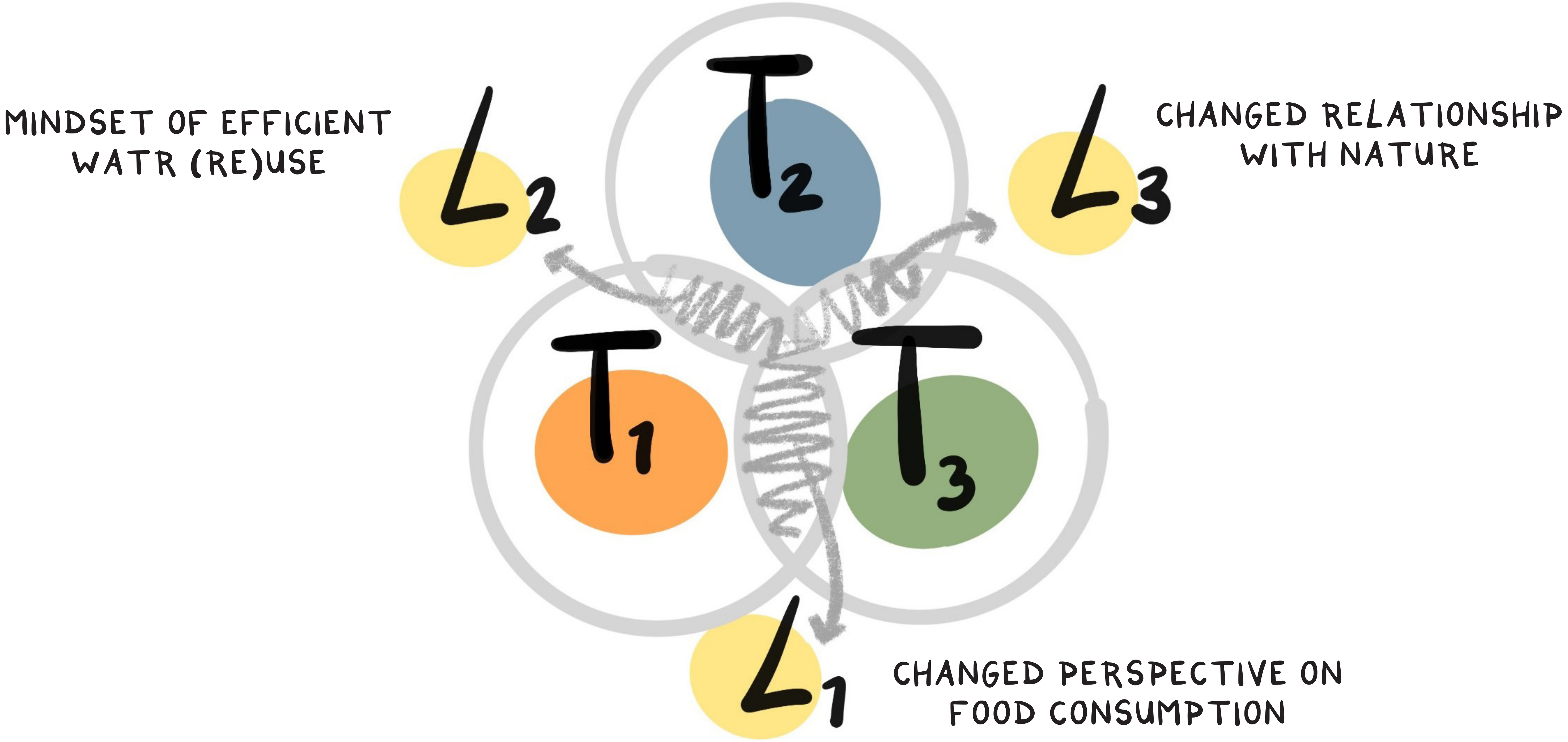
U = URBAN SECTOR

- RIVER BASIN AUTHORITY – CHS
- MCT
- AQUAMED
- MUNICIPALITIES
- SACYR
- GOLF COURSES
- TOURISTS
- RESIDENTS

O = OTHER STAKEHOLDERS

- RESEARCH INSTITUTES
- NATIONAL GOVERNMENT
- MITECO
- TAJO BASIN AUTHORITY
- EU – WFD

DESIGN FRAMEWORK



T_1 AGRICULTURE TRANSITION

T_2 WATER MANAGMENT TRANSITION

T_3 NATURE RESTORATION TRANSITION

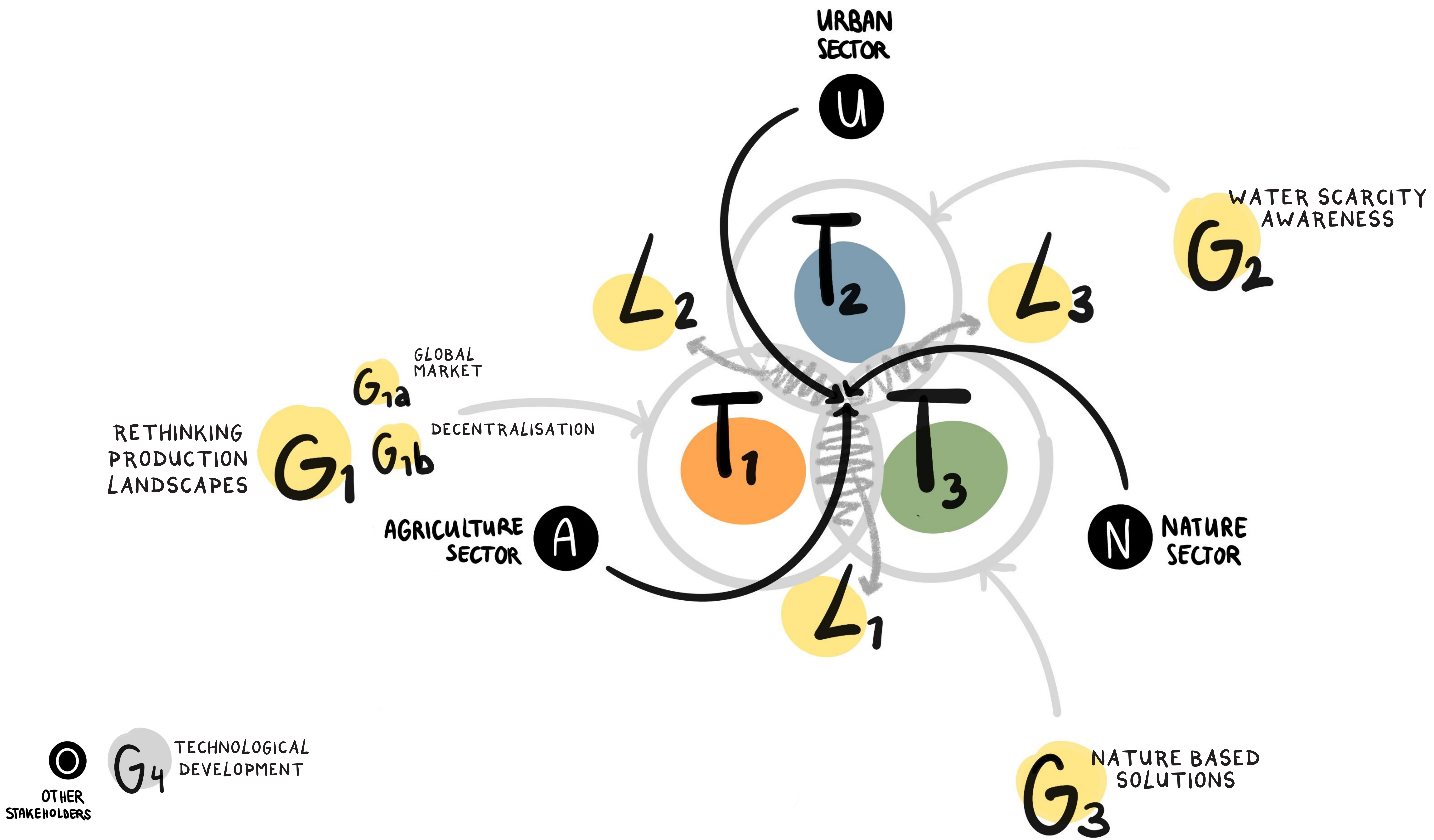
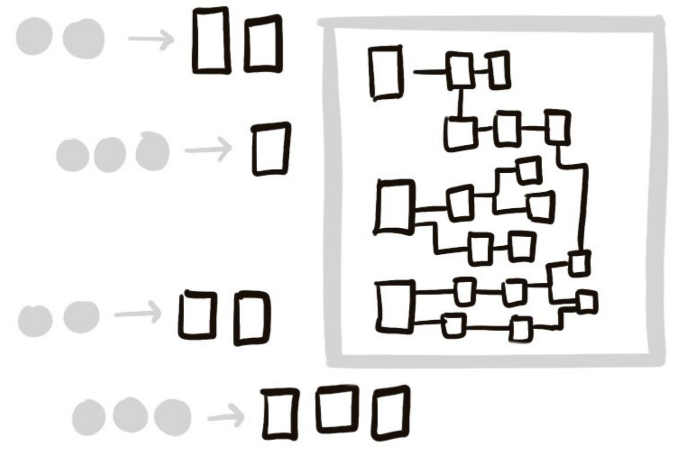


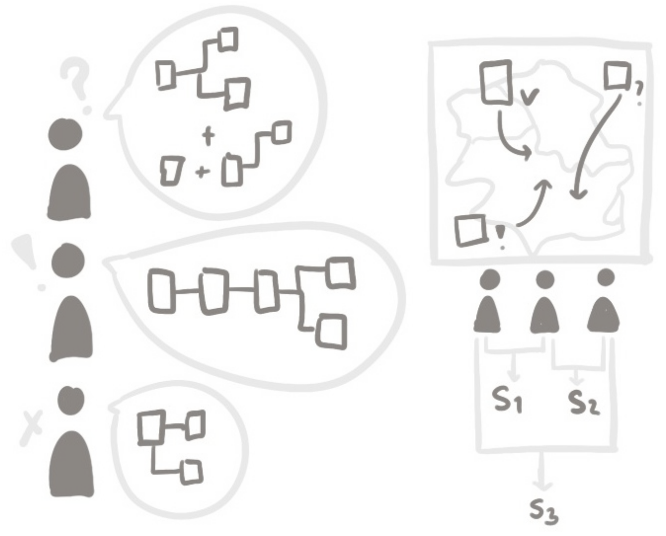
Figure 48. Vision framework: Systemic Symbiosis, global drivers and sectors involved. Source: made by author.

DESIGN

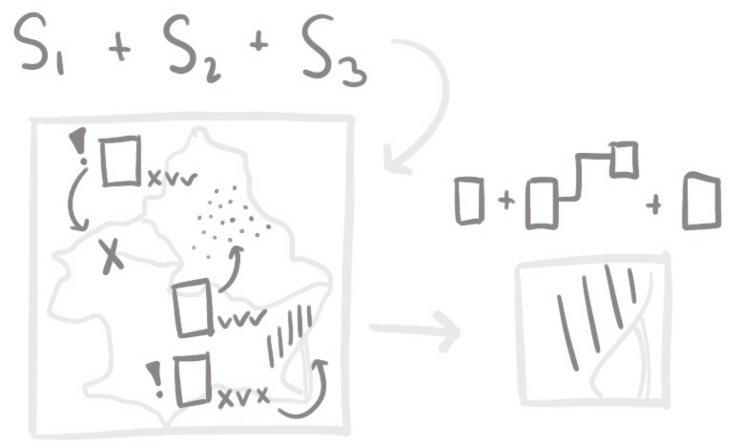
STEP 1



STEP 2



STEP 3



SYMBIOTIC SOLUTIONS

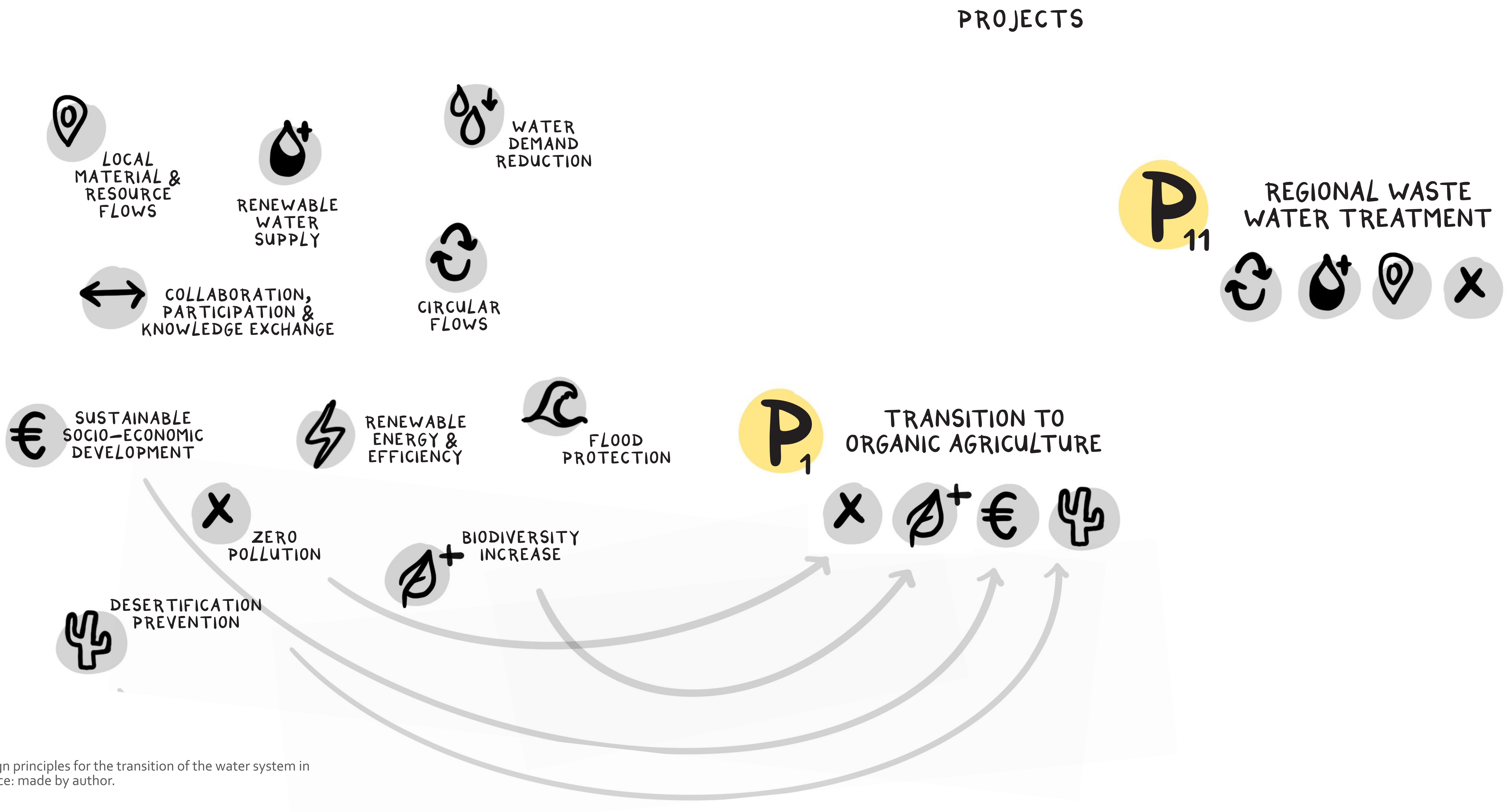
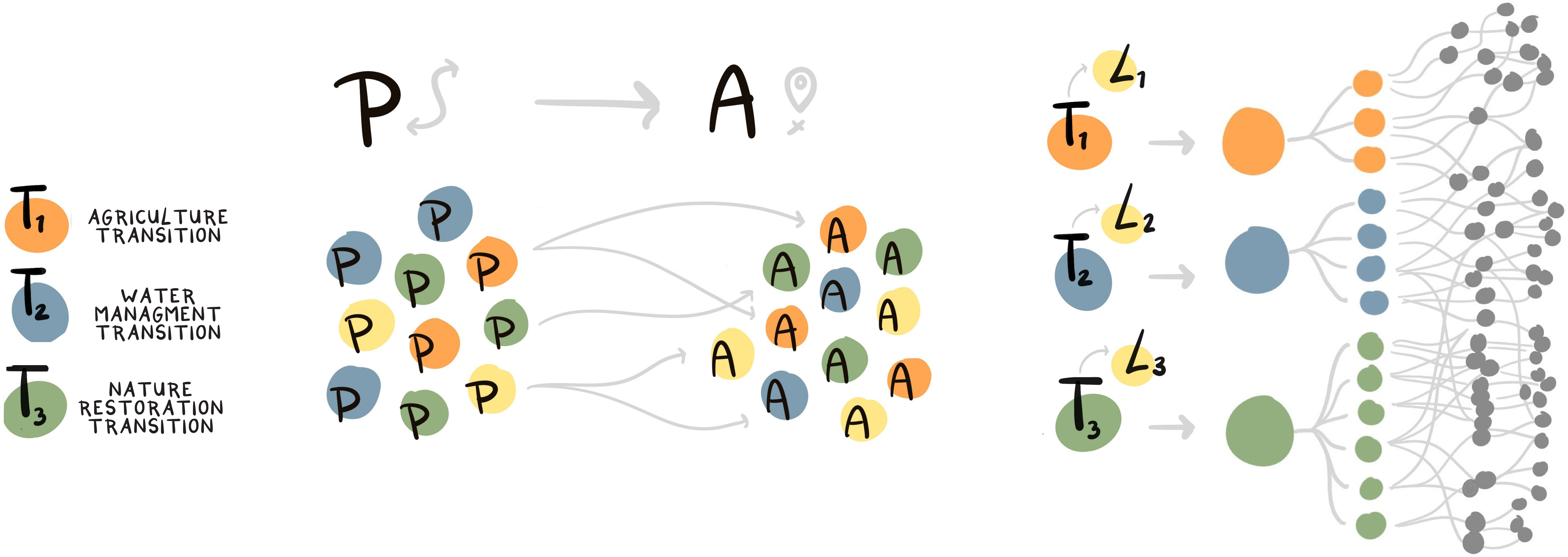


Figure 49. Design principles for the transition of the water system in the region. Source: made by author.

SPATIAL DESIGN CATALOGUE



SOLUTION WEB

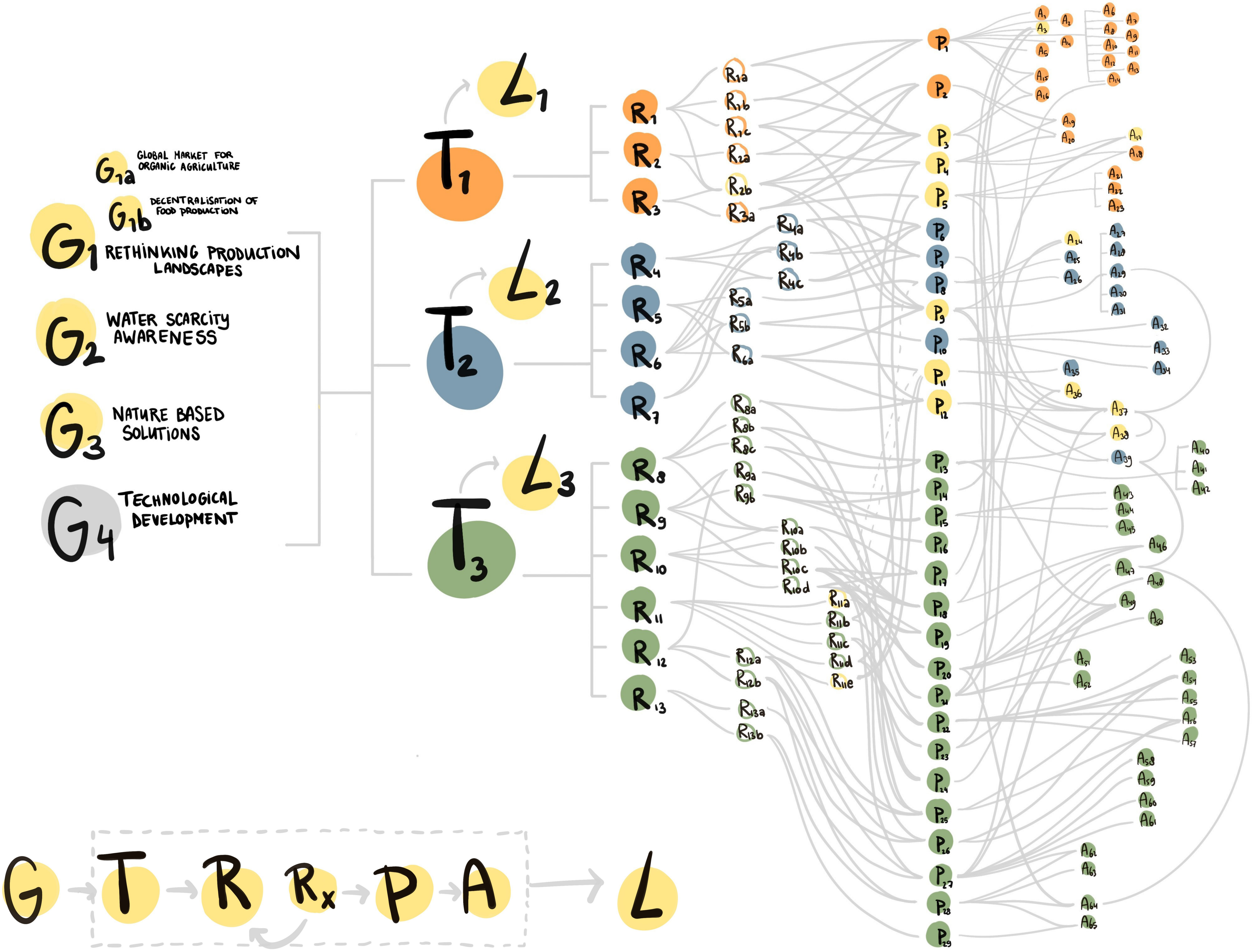
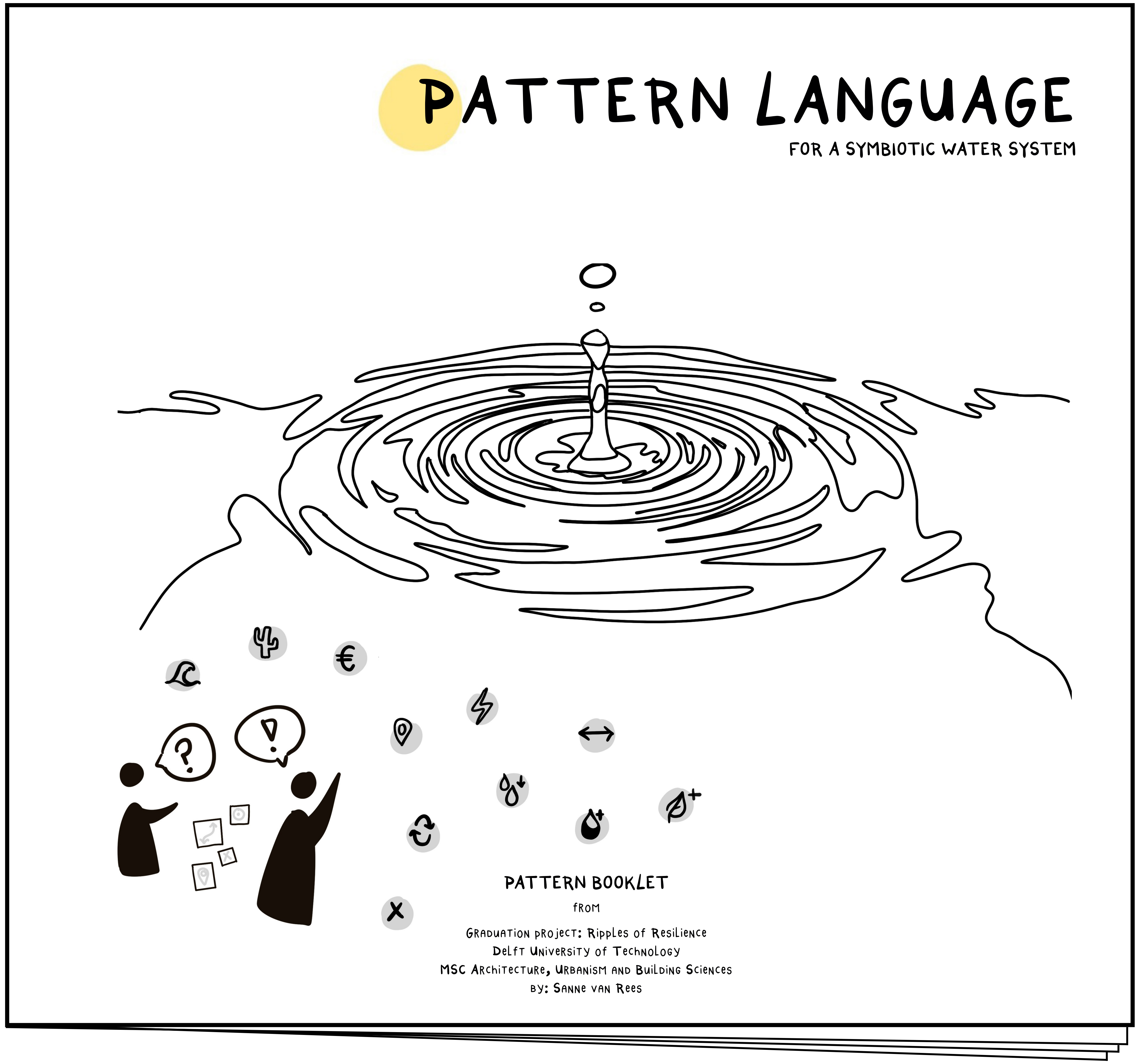


Figure 50. Pattern-web as a decision tree Source: made by author.

Figure 51. Different components of the pattern language. Source: made by author.

PATTERN LANGUAGE

AS A COMMUNICATION AND PARTICIPATION TOOL



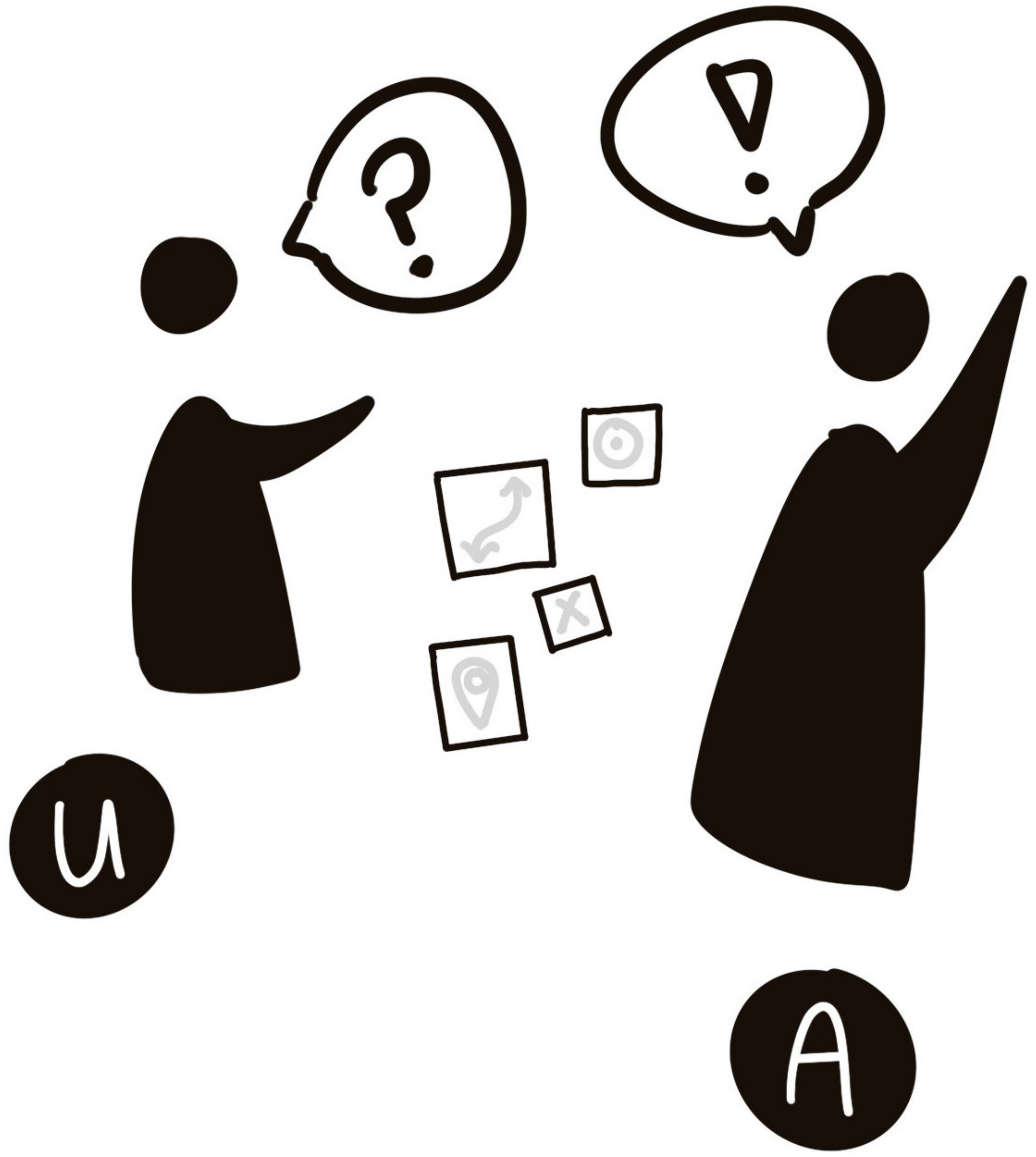
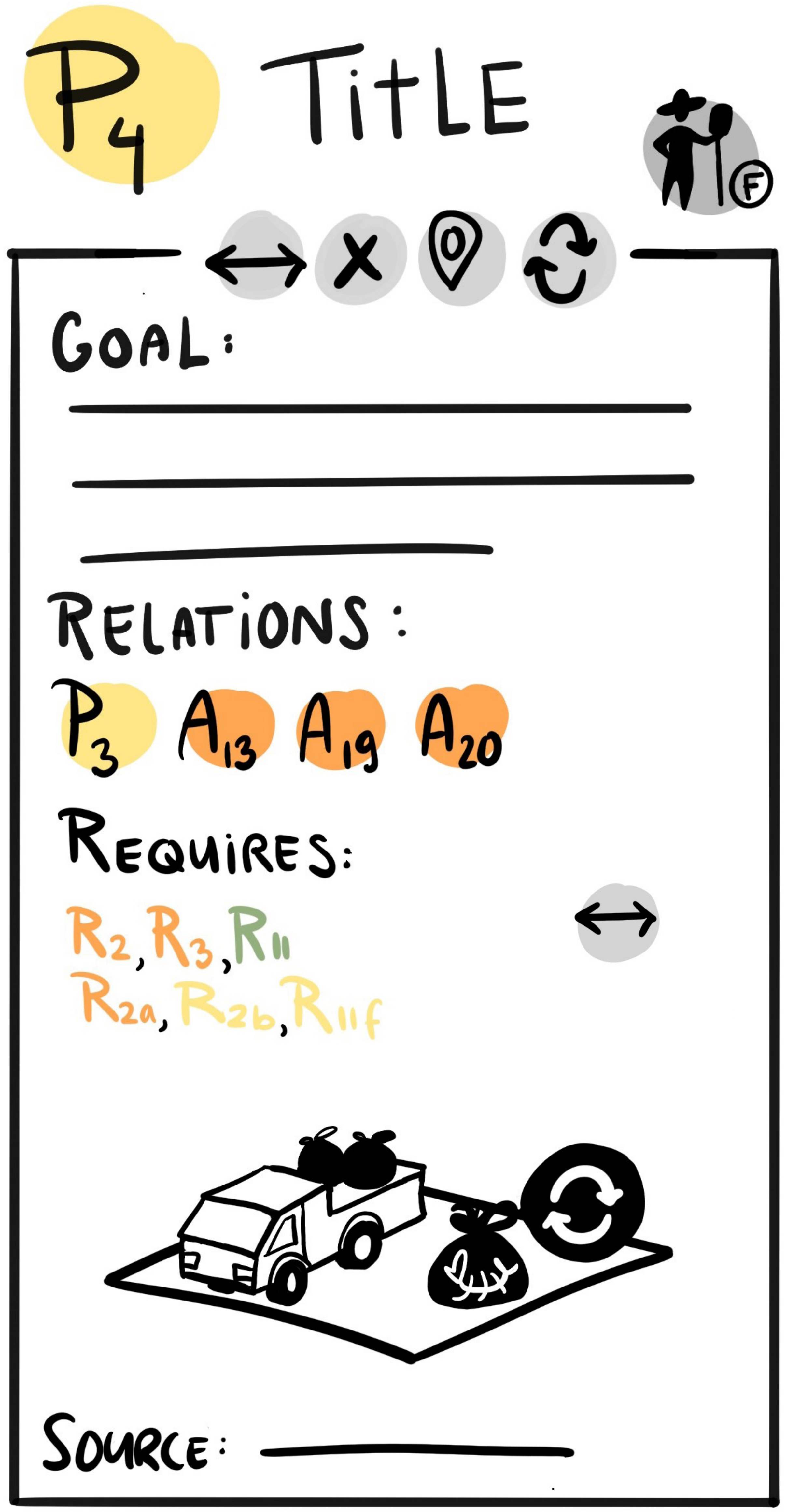


Figure 52. Framework of a pattern language. Source: made by author.

PATTERN CARDS



P — PATTERN SCALE
PATTERN TITLE
4 — PATTERN NUMBER
TRANSITION / CATEGORY
STAKEHOLDER TO OPERATIONALISE
VISION OBJECTIVES

PROBLEM EXPLANATION
HYPOTHESIS SOLUTION

RELATIONS TO (OPERATIONALISATION) PATTERNS

(SPATIAL) REQUIREMENTS – ICONS
REQUIREMENTS NON–SPATIAL
R2a — REQUIRED / POSSIBLE POLICIES

IMAGE

REFERENCE LITERATURE
METHOD USED

Figure 53. Framework for the patterns. Source: made by author.

PATTERN CARDS

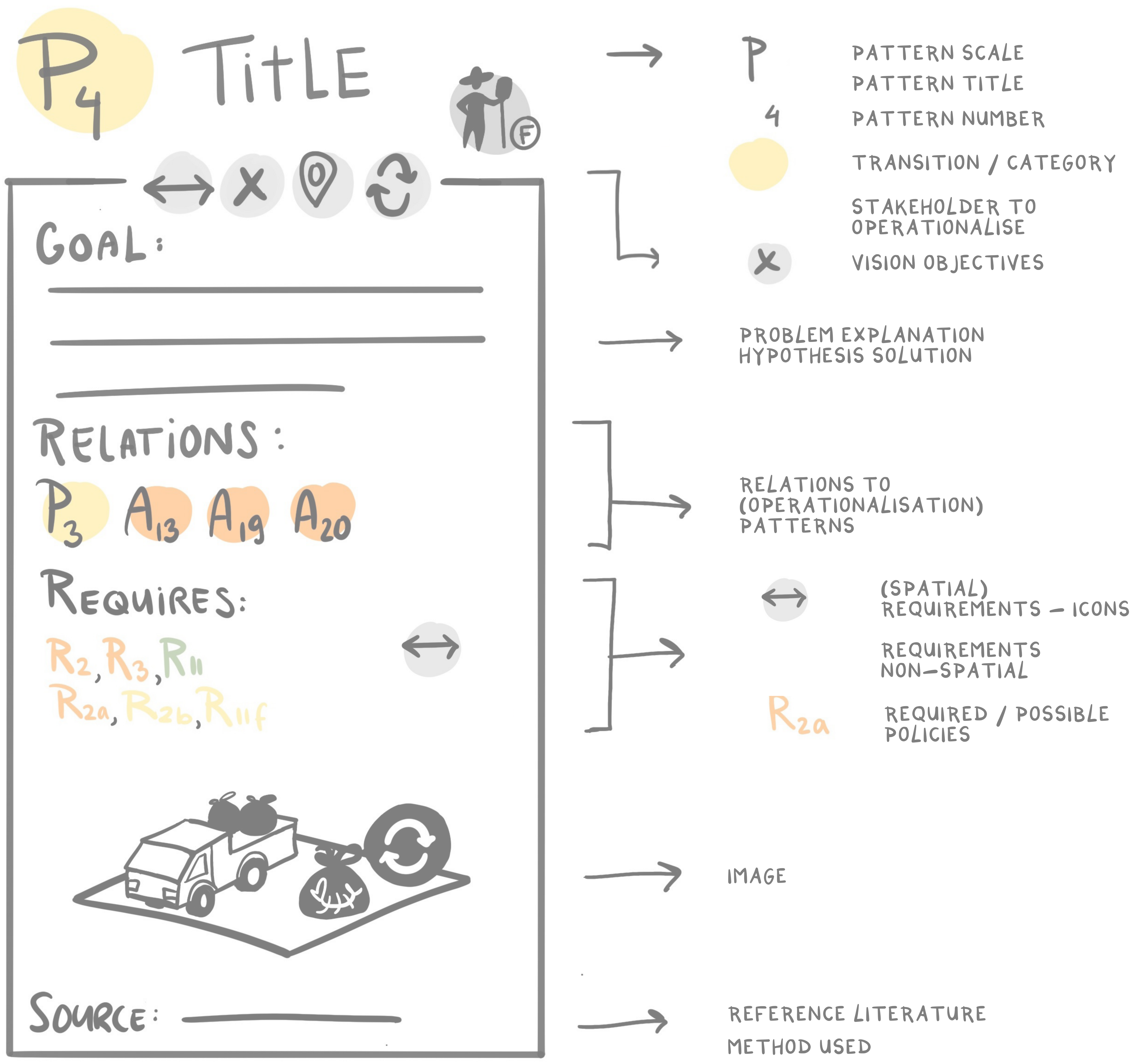


Figure 54. Framework for the patterns. Source: made by author.

P4 CROSS-SECTORAL ORGANIC WASTE SYSTEM

GOAL:

Linear waste systems in agriculture and urban areas often lead to nutrient loss, pollution, and increased dependency on synthetic inputs. Implementing a cross-sectoral organic waste collection and reuse system focusing on composting, manure exchange, and inter-sectoral redistribution, addresses these inefficiencies by closing nutrient loops at the regional scale. By transforming local organic waste into valuable inputs such as compost, biochar, or organic mulch, the system promotes soil restoration, reduces reliance on chemical fertilisers, and supports organic farming practices. Additionally, facilitating manure exchange among farmers or between sectors like agriculture, landscaping, and golf courses reduces logistical burdens, prevents over-application and runoff, and helps combat desertification. This systemic approach supports circularity, enhances ecosystem resilience, and creates shared economic and ecological value across urban-rural interfaces (FAO, 2025).

RELATIONS WITH:

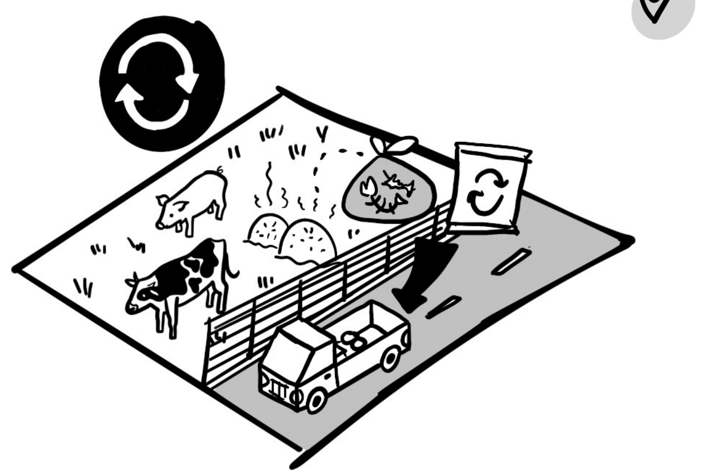
Possible Actions: A7, A8, A13, A15, A16, A19, A36, A42

To be combined with: P1, P2, P3, P5, P9, P11, P13, P22, P24

REQUIRES:

Focus: (R1), R2, R11

Policies: (R1a, R1b, R1c), R2a, R2b, (R8c), (R10c), R11e

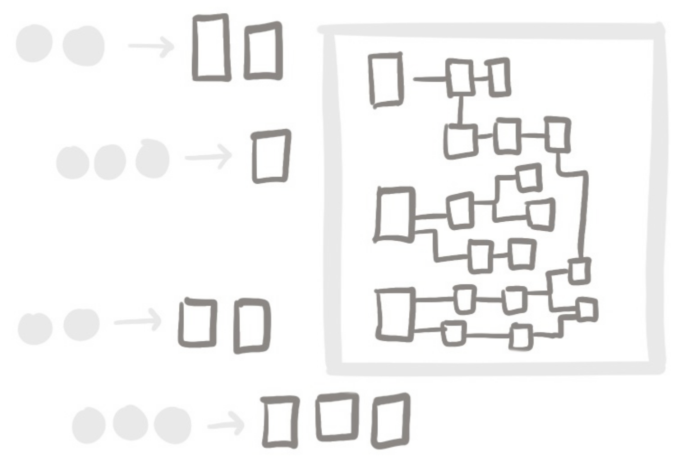


SOURCE: (FAO, 2025)

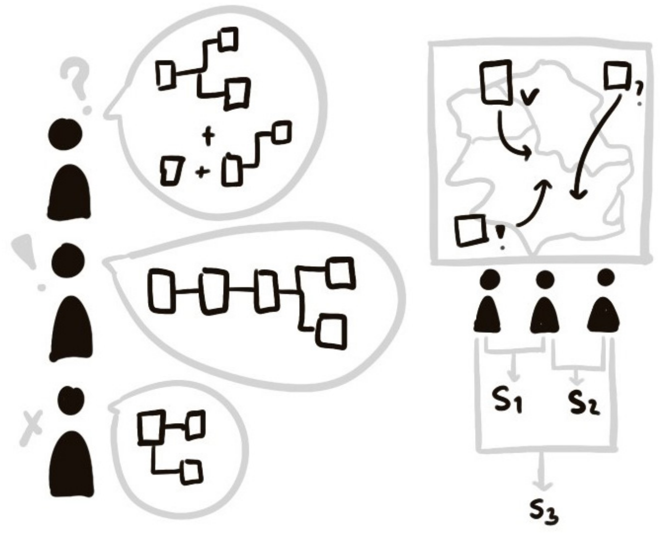
OBTAINED THROUGH: Design intuition|Literature study

DESIGN

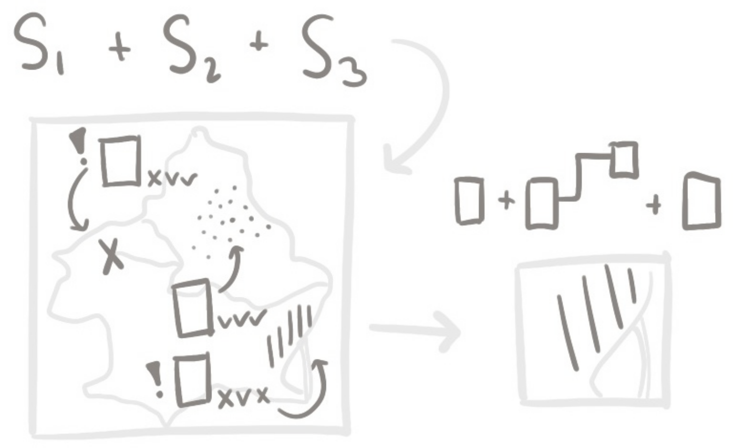
STEP 1



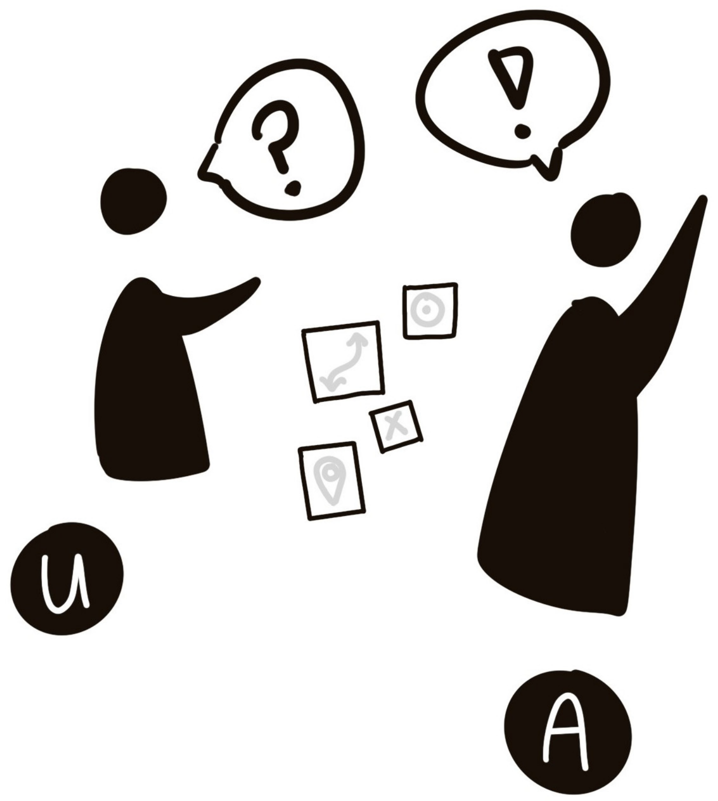
STEP 2

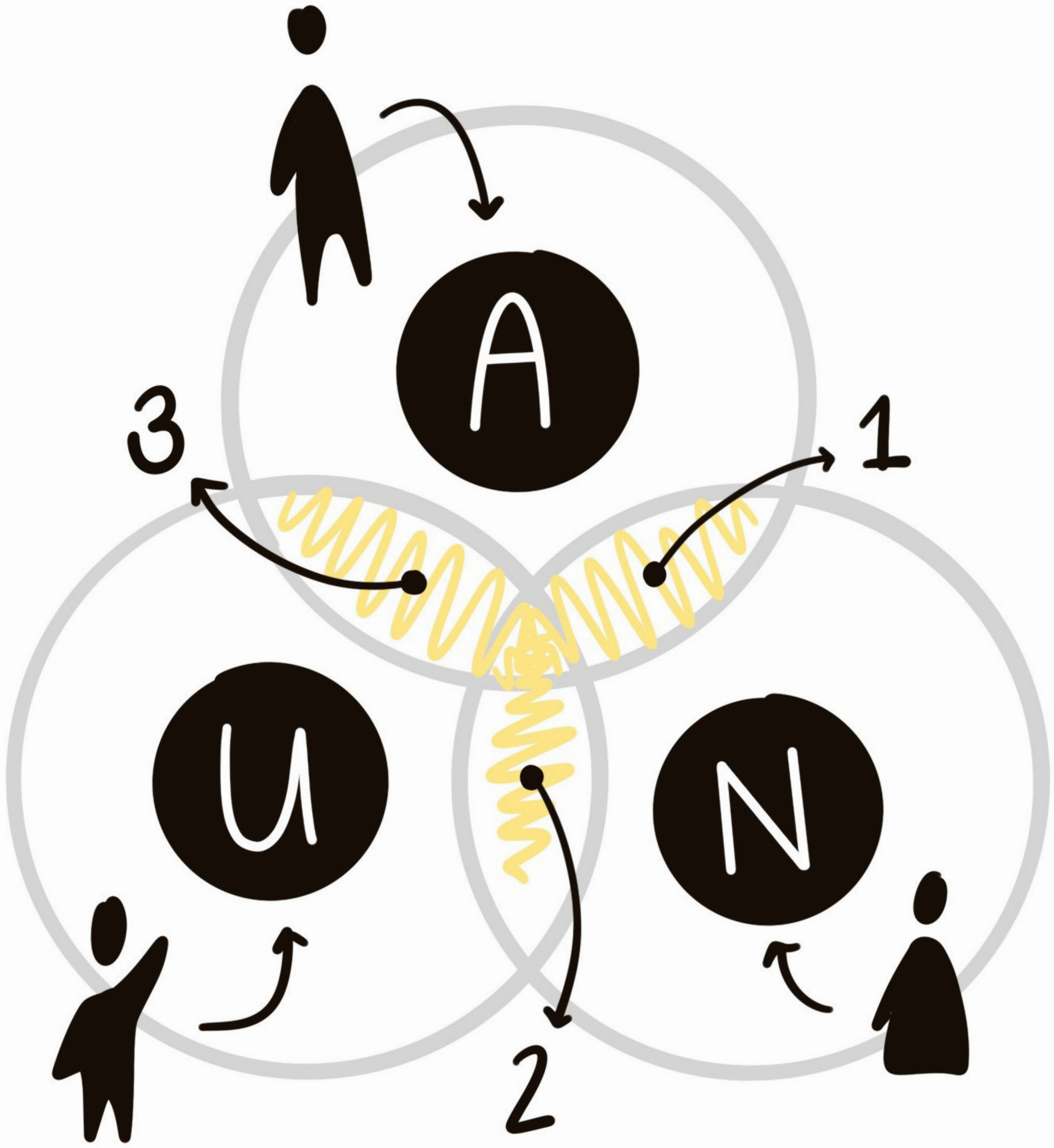


STEP 3



SCENARIO FRAMEWORK





SCENARIO 1: ORGANIC PRODUCE

AGRICULTURE + NATURE
ORGANIC AGRICULTURE EXPORT
SOIL REVITALISATION

SCENARIO 2: SELF-SUFFICIENCY

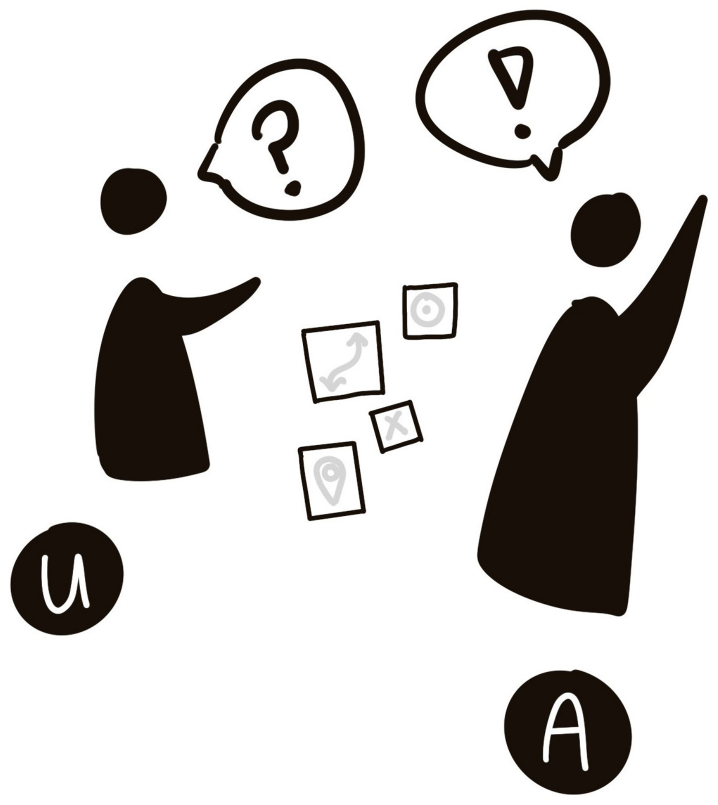
NATURE + URBAN
LOCAL PRODUCTION
NATURE CONNECTION

SCENARIO 3: INNOVATIVE PRODUCTION

URBAN + AGRICULTURE
TECHNOLOGICAL FOOD PRODUCTION EXPORT
RENEWABLE ENERGY & WATER

Figure 55. Scenario framework, made by author.

SECTOR SYMBIOSIS



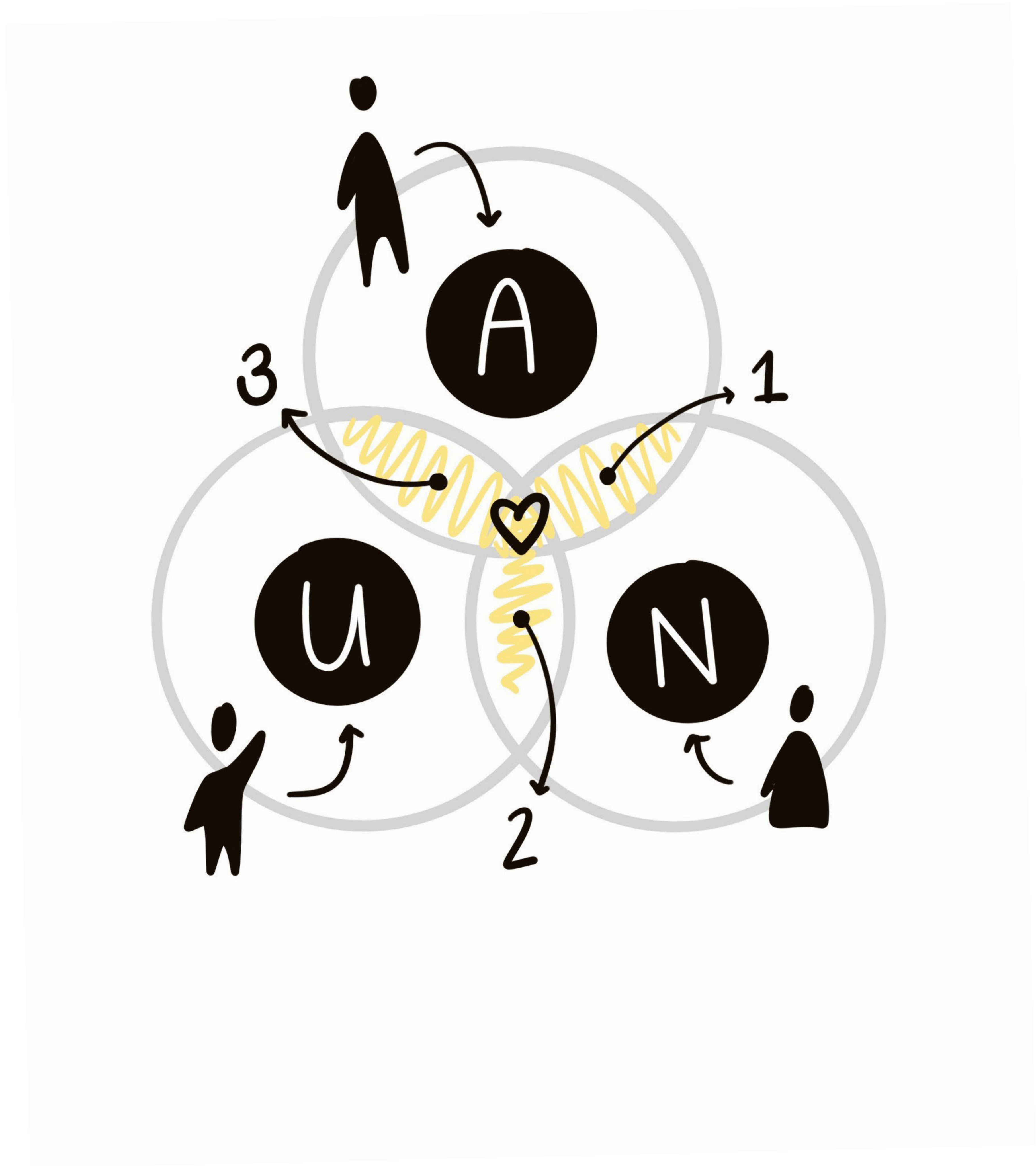
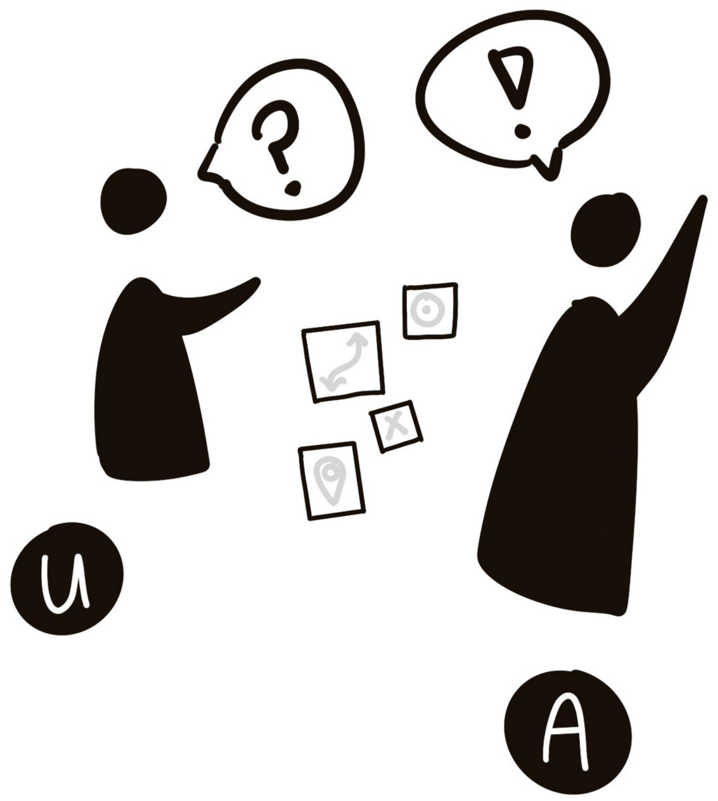


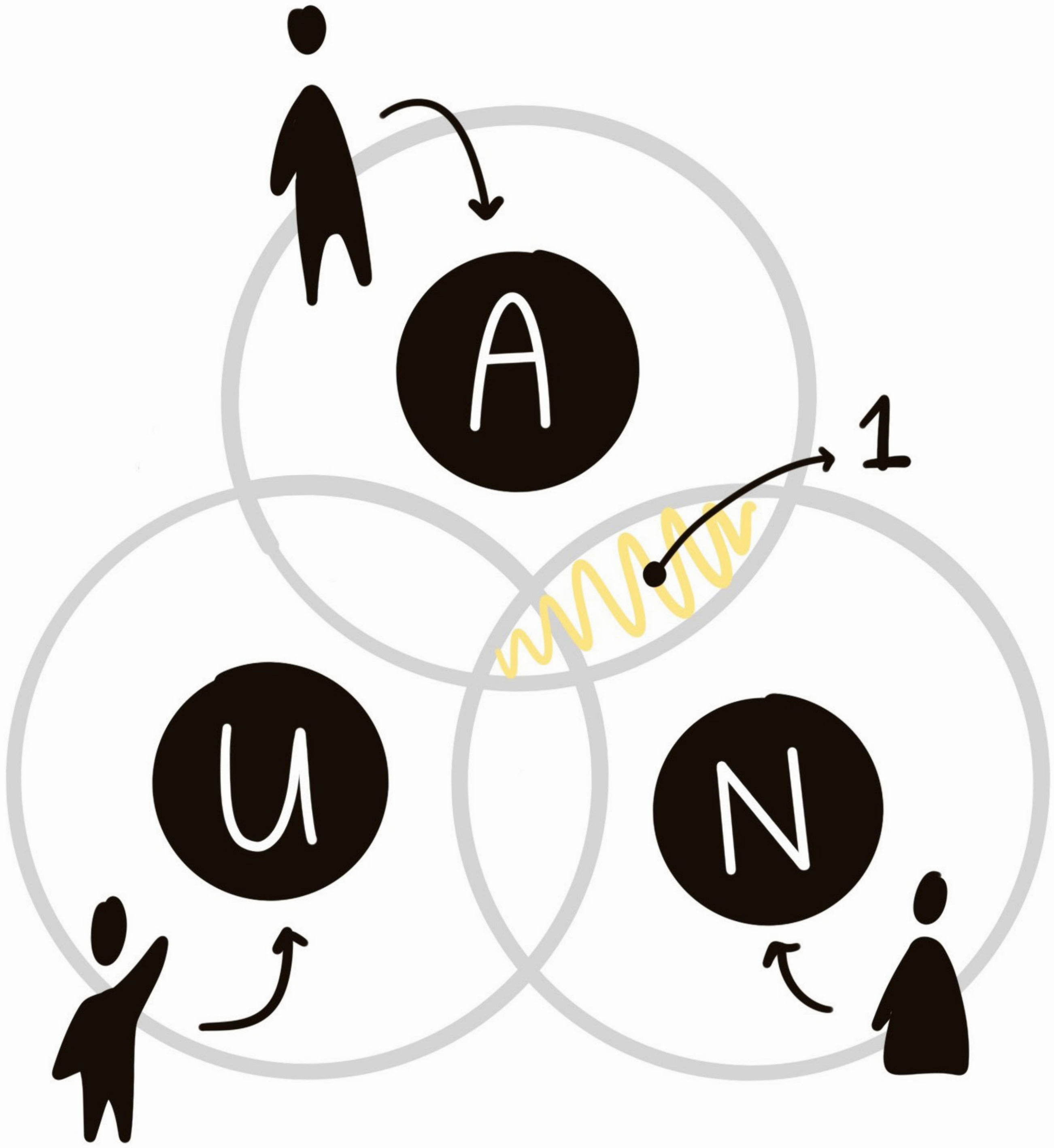
Figure 56. Scenario framework, made by author.

SCENARIO EXAMPLE

SCENARIO 1

A + N

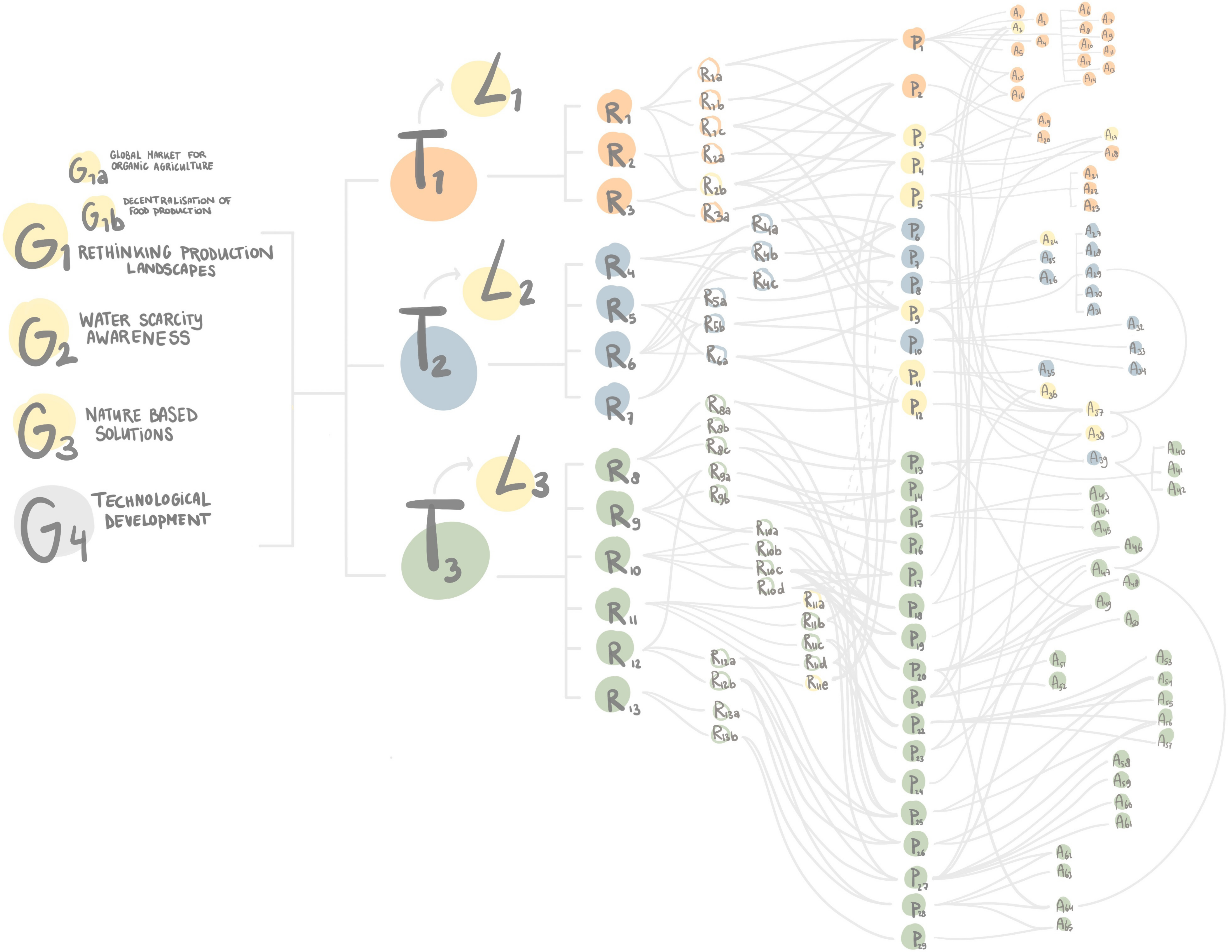




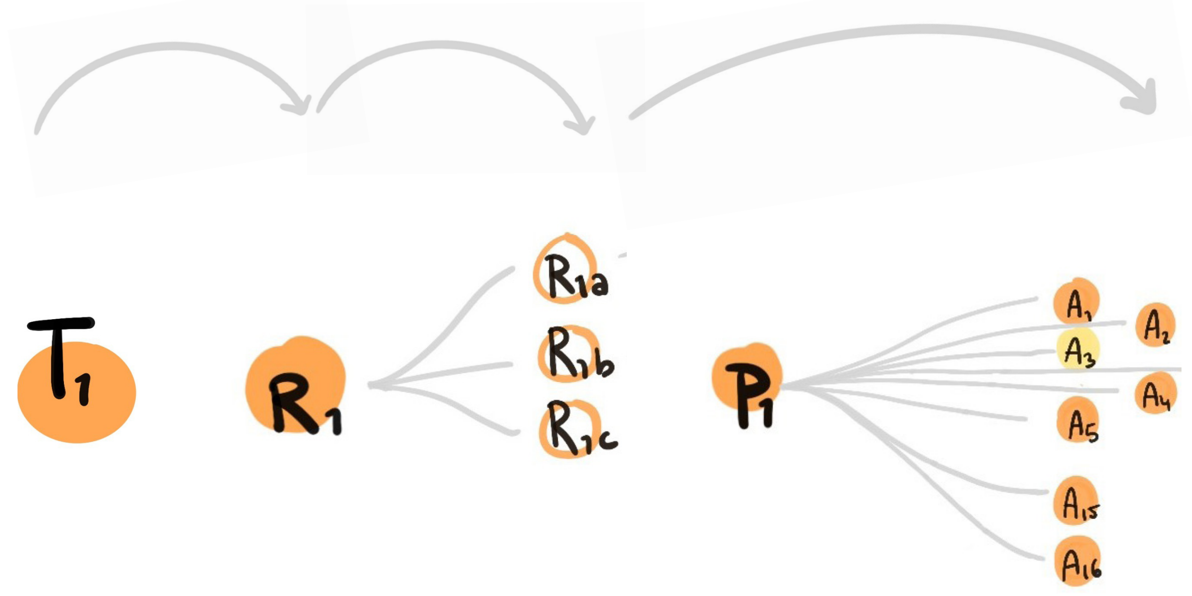
SCENARIO 1: ORGANIC PRODUCE

AGRiCULTURe + NATURe
ORGANiC AGRiCULTURe exPORT
SOiL ReViTALiSATiON

PATTERN WEB



1 TOP-DOWN DESIGN APPROACH



2 BOTTOM-UP DESIGN APPROACH

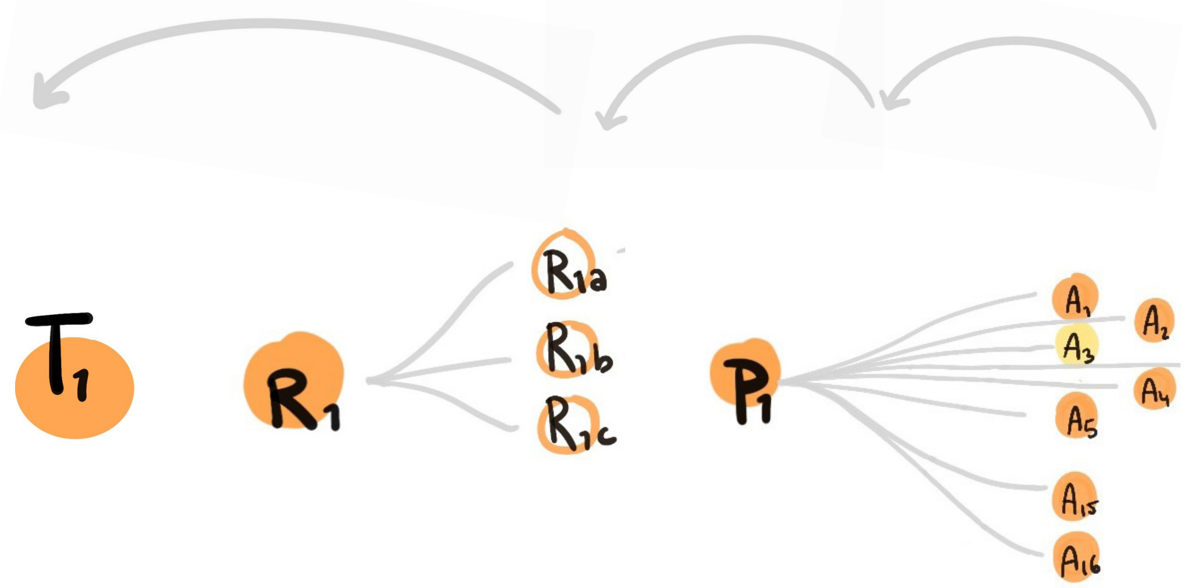
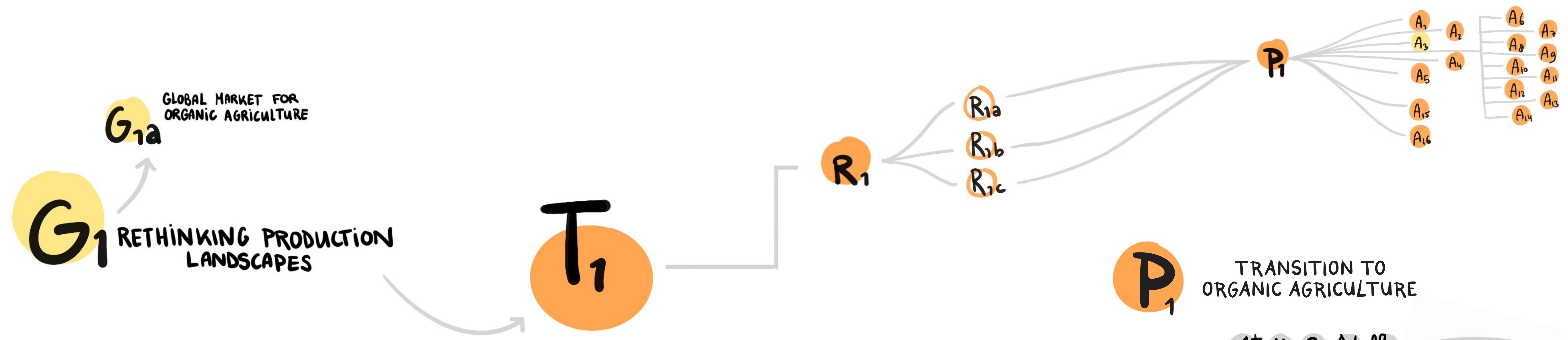


Figure 57. Pattern-web as a decision tree Source: made by author.

Figure 58. Different components of the pattern language. Source: made by author.



SCENARIO 1

ORGANIC PRODUCE

A + N

P1 TRANSITION TO ORGANIC AGRICULTURE

GOAL:

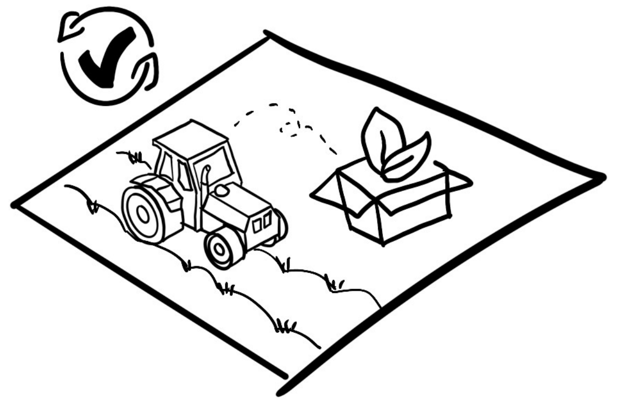
Transitioning current intensive agricultural practices to organic agriculture methods. Organic farming is a system of agricultural produciton based on the use of natural processes and resources, where no chemicals or genetically modified organisms are used (Iberdrola, 2021). Through potential higher crop yields, less costs for fertilisers and pesticides and the use of natural processes, this method is likely to be beneficial for famers as well as natural systems. Multiple actions to oprationalise this project are possible, where the collective aims are to depollute the natural substrate by reducing agricultural pollutants from fertiliser or pesticide use, improve local biodiversity, and combat desertification and decrease flood risk in agricultural soils by improving the water retention capacity.

RELATIONS WITH:

Operationalised by: A1-A5 + A6-A14
Related to: A17, A18
To be combined with: P2, P3, P4, P9, P13, (P5), (P12), (P18), A15, A16, A19, A20, A21-A23, A27-A31, A37, A38, A39, A40-A42

REQUIRES:

Focus: R1
Policies: R1a, R1b, R1c



SOURCE: Iberdrola (2021)

A_{1-5} + A_{6-14}

- A_1 CHANGE TO DROUGHT-TOLERANT CROPS
- A_2 TERRACING AGRICULTURE
- A_3 LAND TRANSFORMATION TO NATURAL LANDSCAPE
- A_4 CHANGE TO SALT-TOLERANT CROPS
- A_{5-14} ...

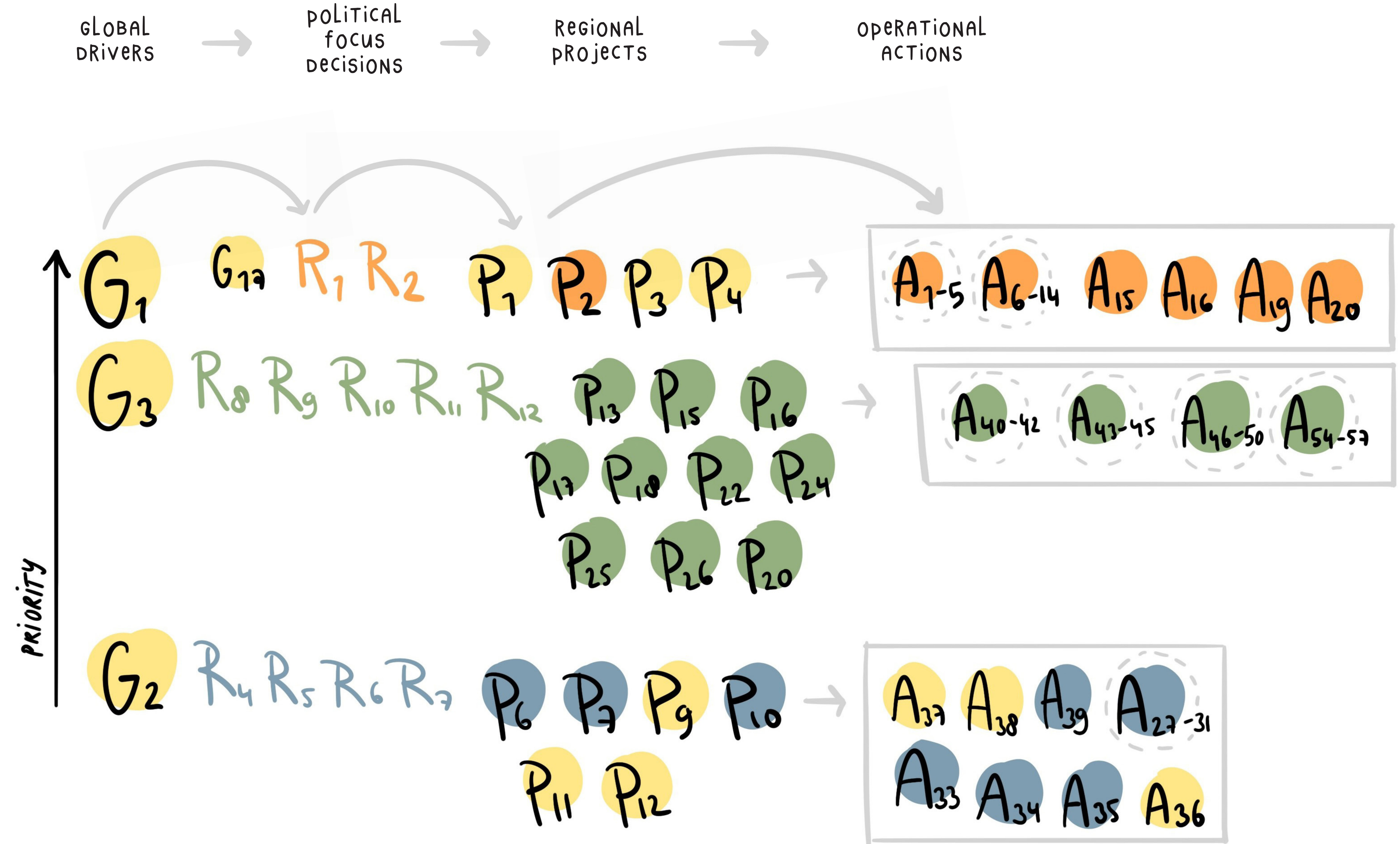
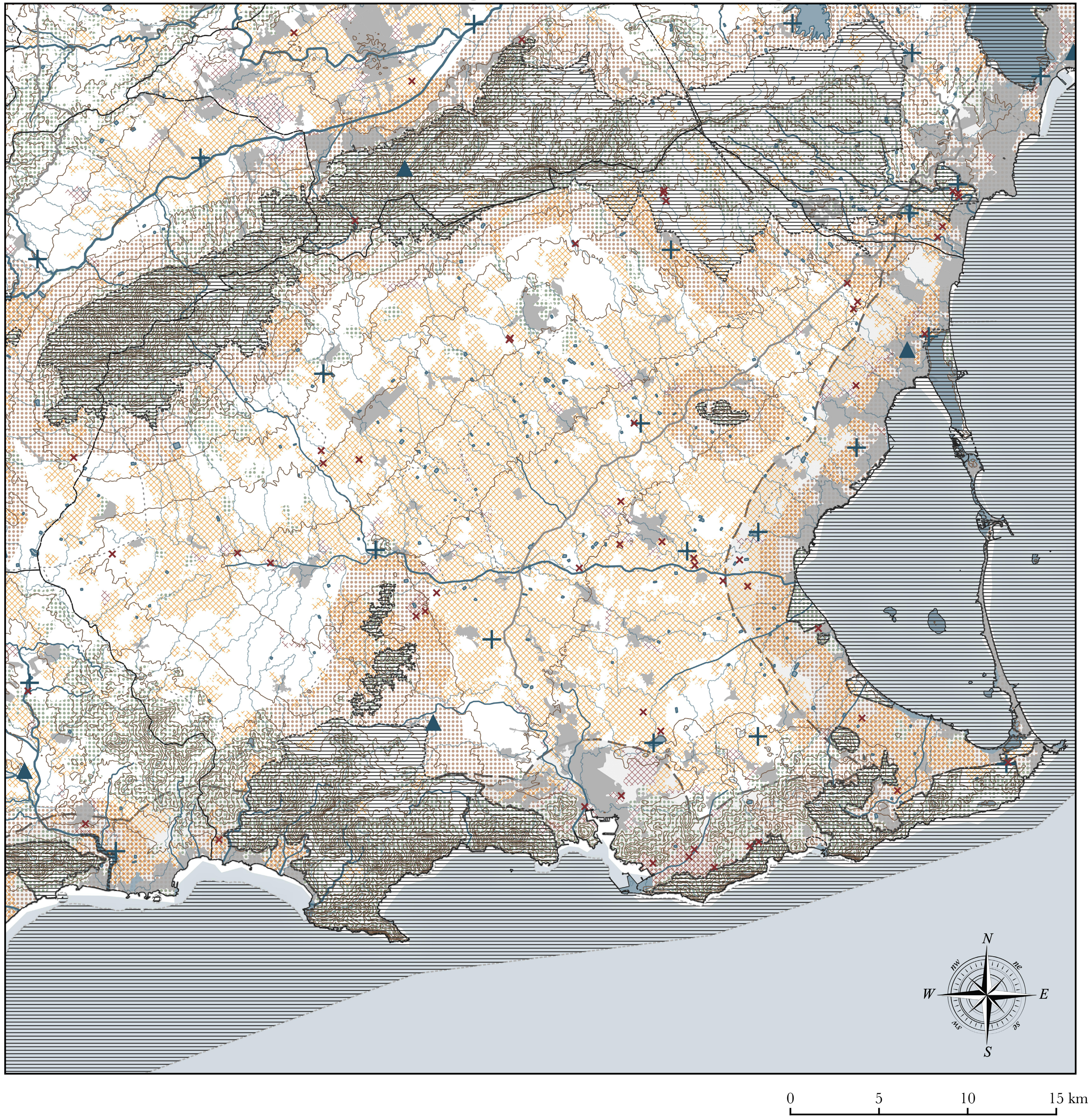


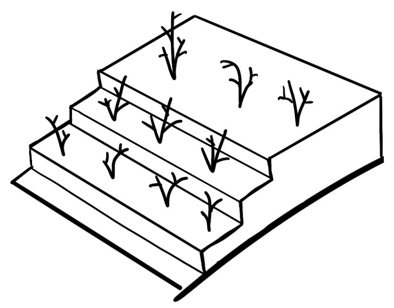
Figure 59. Selection of scenario based patterns for scenario 1. Source: made by author.



SPATIAL REQUIREMENTS

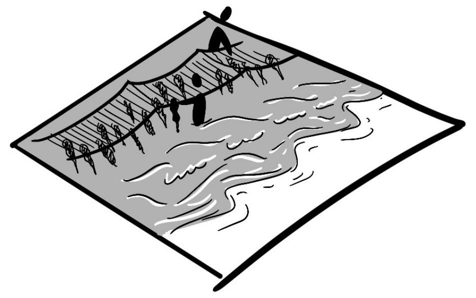
SPATIAL PRECONDITION ICONS

A2 TERRACING AGRICULTURE



= SLOPED TERRAIN

A5 SEAWEED FARMING



= PROXIMITY TO THE SEA

Legend

- SRB outline
- Sub-basins
- Municipalities
- Rambla
- Segura river
- TST
- Wastewater treatment plants
- Desalination plants
- Drainage network
- Salines and seawater
- 5km buffer around the coast → = PROXIMITY TO THE SEA
- Urban area → = PROXIMITY TO URBAN CORE
- Industry
- Permanently irrigated land: monocultures → = POLLUTED AREA
- Nitrate pollution
- Countour lines → = SLOPED TERRAIN
- Protected areas outline
- Protected areas
- Sclerophyllous vegetation, Natural grasslands, Coniferous forest → = PROXIMITY TO (PROTECTED) NATURAL AREA
- 2km buffer around Natura 2000 sites

Figure 60. Map of the sub-basin: cumulative map of the spatial requirements for the patterns. Source: made by author.

SCENARIO BUILDING

1. FOOD INDUSTRY LENS

↑ G_1 G_{17} R_1 R_2 P_1 P_2 P_3 P_4 → A_{1-5} A_{6-14} A_{15} A_{16} A_{19} A_{20}

P_1 ORGANIC AGRICULTURE

P_2 LOCAL FOOD HUBS

P_4 ORGANIC WASTE SYSTEM

+ P_3 FOOD POLICY COUNCILS =

A_1 DROUGHT TOLERANT CROPS

A_3 LAND TRANSFORMATION

A_5 SEAWEED PRODUCTION

A_{13-14} SILVO-PASTURES

A_2 TERRACING AGRICULTURE

A_4 SALT TOLERANT CROPS

A_{6-12} ORGANIC FARMING

SCENARIO BUILDING

2. NATURAL LANDSCAPE LENS

G_3 R_8 R_9 R_{10} R_{11} R_{12} P_{13} P_{15} P_{16} P_{17} P_{18} P_{22} P_{24} P_{25} P_{26} P_{20} → A_{40-42} A_{43-45} A_{46-50} A_{54-57}

P_{25} WETLAND CREATION

P_{26} RAMBLA EXPANSION

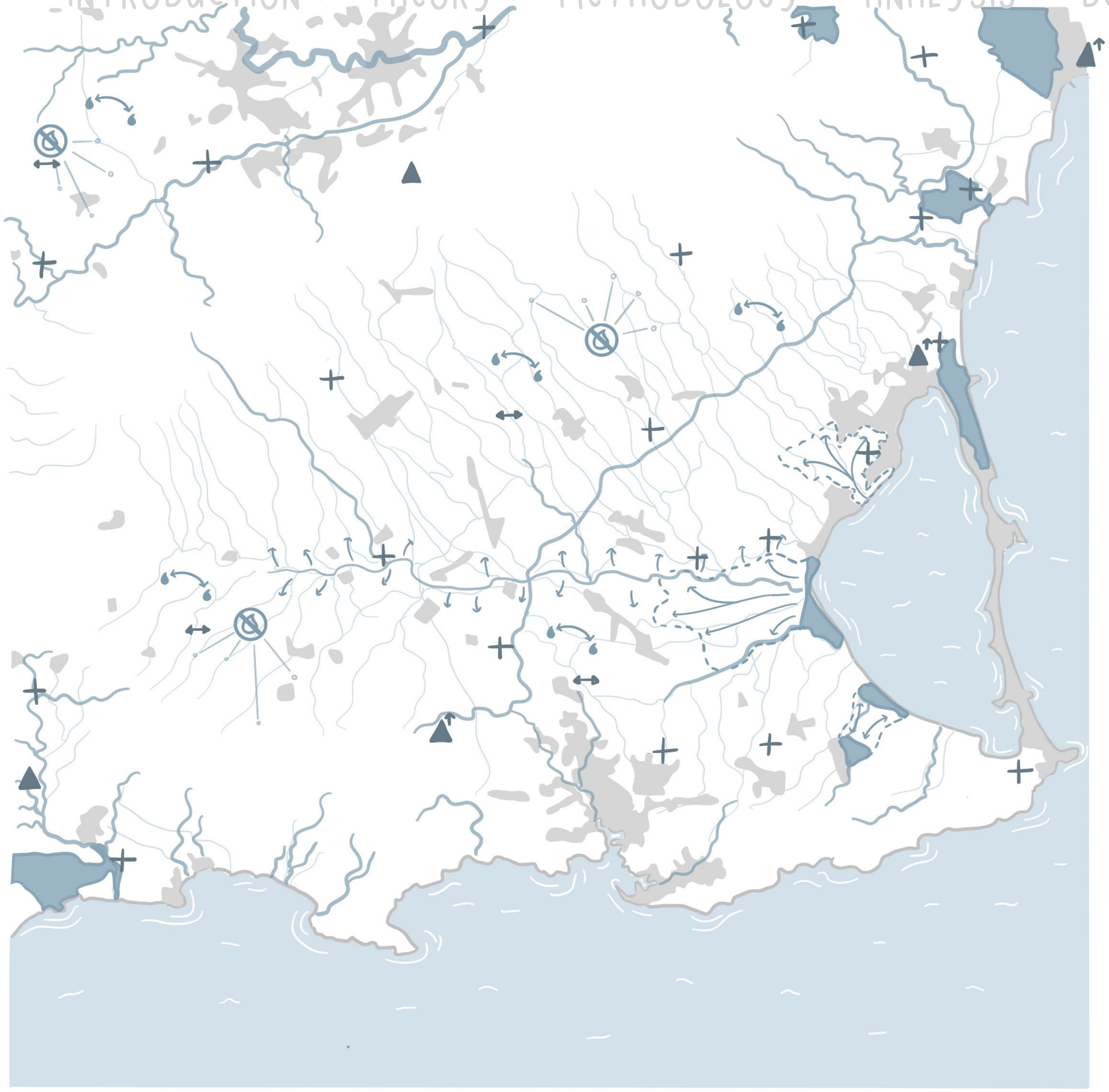
P_{18} ECOLOGICAL CORRIDORS

P_{13} SOIL RESTORATION

P_{22} = A_{54-57} DEPOLLUTION – PHYTOREMEDIATION

P_{17} REFORESTATION

P_{20} BIODIVERSITY PROJECTS



SCENARIO BUILDING

3. WATER MANAGEMENT LENS

G_2 R_4 R_5 R_6 R_7 P_6 P_7 P_9 P_{10} P_{11} P_{12} → A_{37} A_{38} A_{39} A_{27-31} A_{33} A_{34} A_{35} A_{36}

P_6 LIMITED GROUNDWATER EXTRACTION

P_9 = $A_{37}+49$ DRYFARMING AGRICULTURAL RETURN FLOWS

P_{10} RAINWATER COLLECTION

P_8 UPGRADE DESALINATION SYSTEM

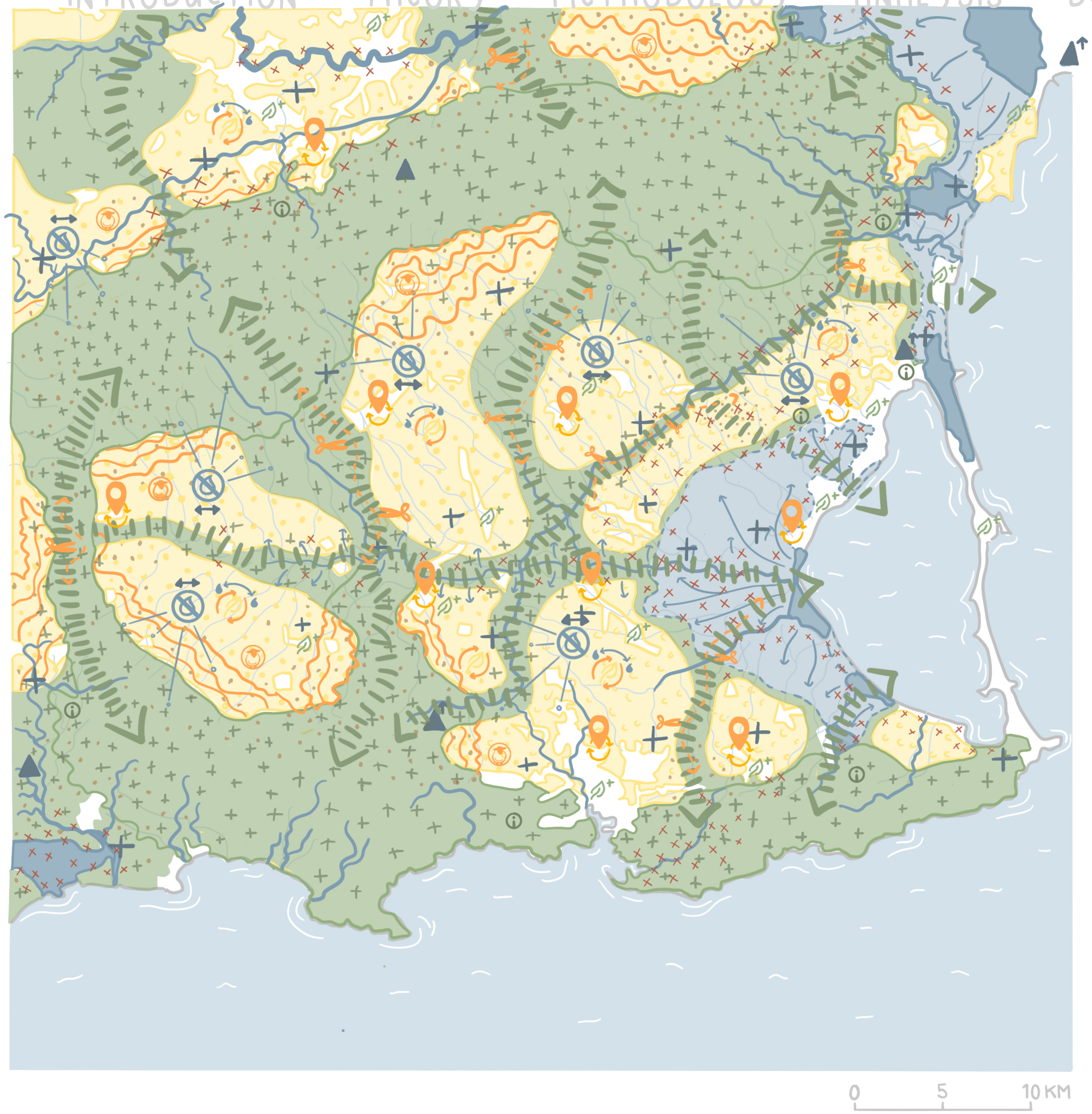
P_{12} CO—MANAGE WATER RESOURCES

P_{11} IMPROVE WASTEWATER TREATMENT SYSTEM

SCENARIO 1

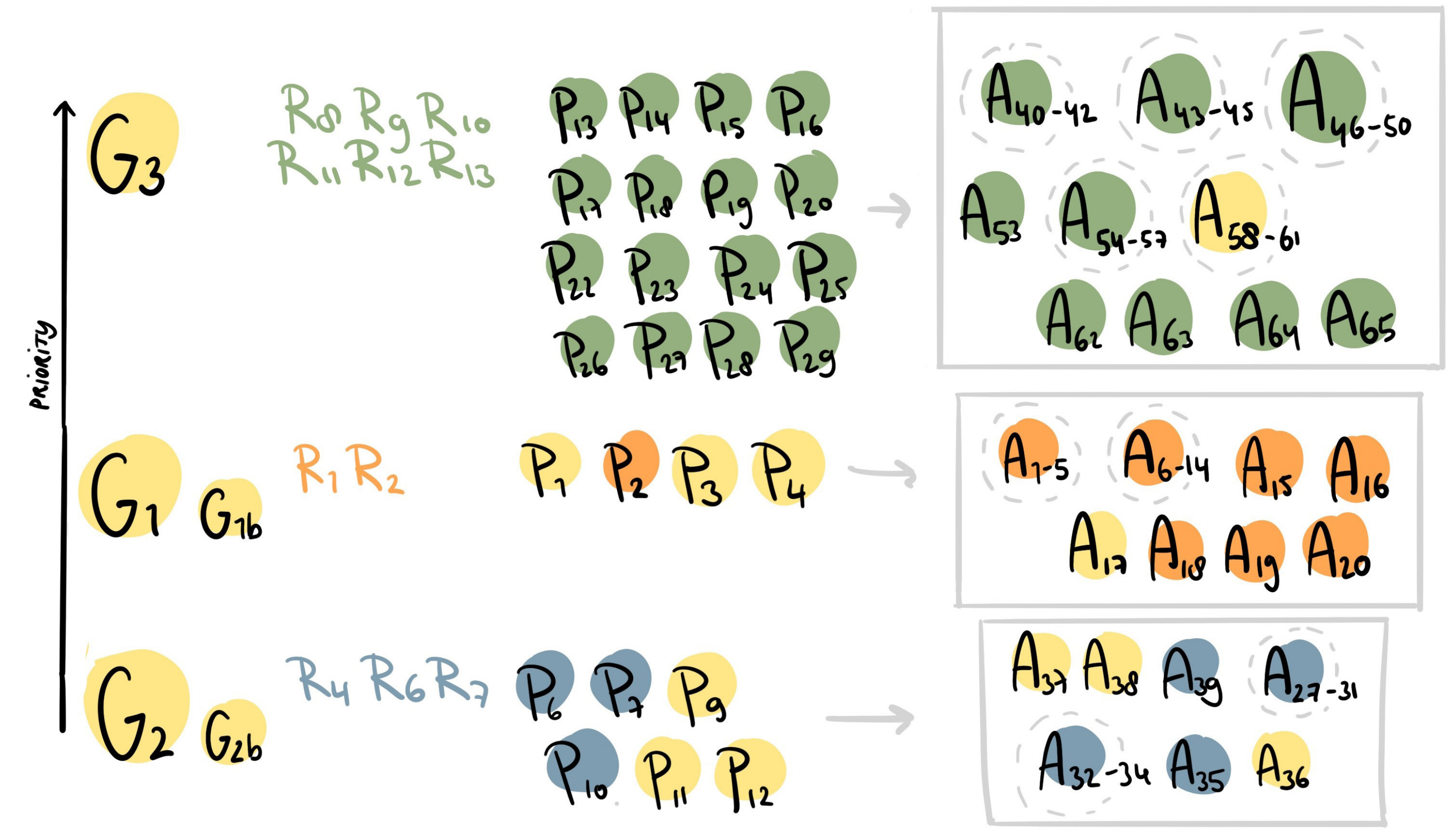
FULL SCENARIO MAP

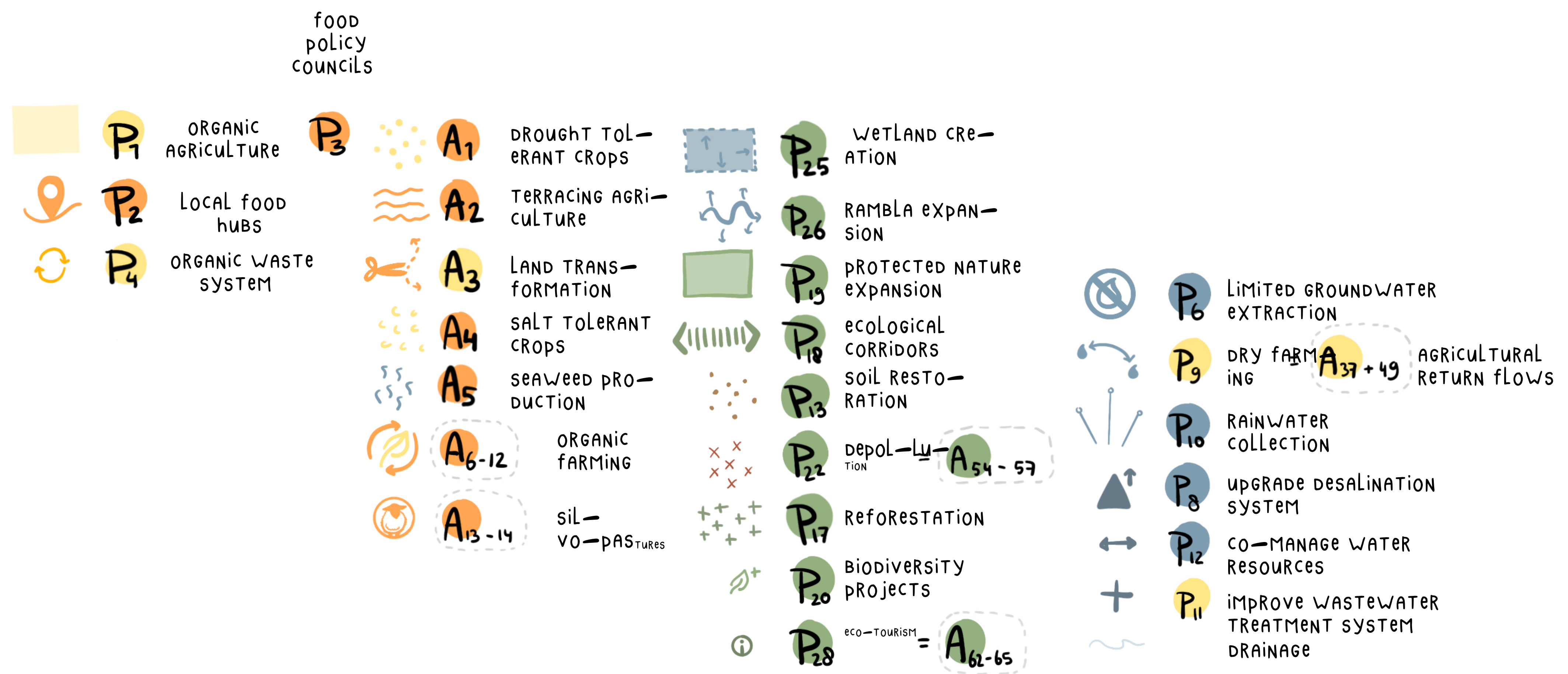
- P_1 ORGANIC AGRICULTURE + P_3 FOOD POLICY COUNCILS =
- P_2 LOCAL FOOD HUBS
- P_4 ORGANIC WASTE SYSTEM
- A_1 DROUGHT TOLERANT CROPS
- A_2 TERRACING AGRICULTURE
- A_3 LAND TRANSFORMATION
- A_4 SALT TOLERANT CROPS
- A_5 SEAWEED PRODUCTION
- A_{6-12} ORGANIC FARMING
- A_{13-14} SILVO-PASTURES
- P_{25} WETLAND CREATION
- P_{26} RAMBLA EXPANSION
- P_{19} PROTECTED NATURE EXPANSION
- P_{18} ECOLOGICAL CORRIDORS
- P_{13} SOIL RESTORATION
- P_{22} DEPOLLUTION = A_{54-57} PHYTOREMEDIATION
- P_{17} REFORESTATION
- P_{20} BIODIVERSITY PROJECTS
- P_{28} = A_{62-65} ECO-TOURISM
- P_6 LIMITED GROUNDWATER EXTRACTION
- P_9 DRY FARMING = $A_{37}+49$ AGRICULTURAL RETURN FLOWS
- P_{10} RAINWATER COLLECTION
- P_8 UPGRADE DESALINATION SYSTEM
- P_{12} CO-MANAGE WATER RESOURCES
- P_{11} IMPROVE WASTEWATER TREATMENT SYSTEM
- DRAINAGE

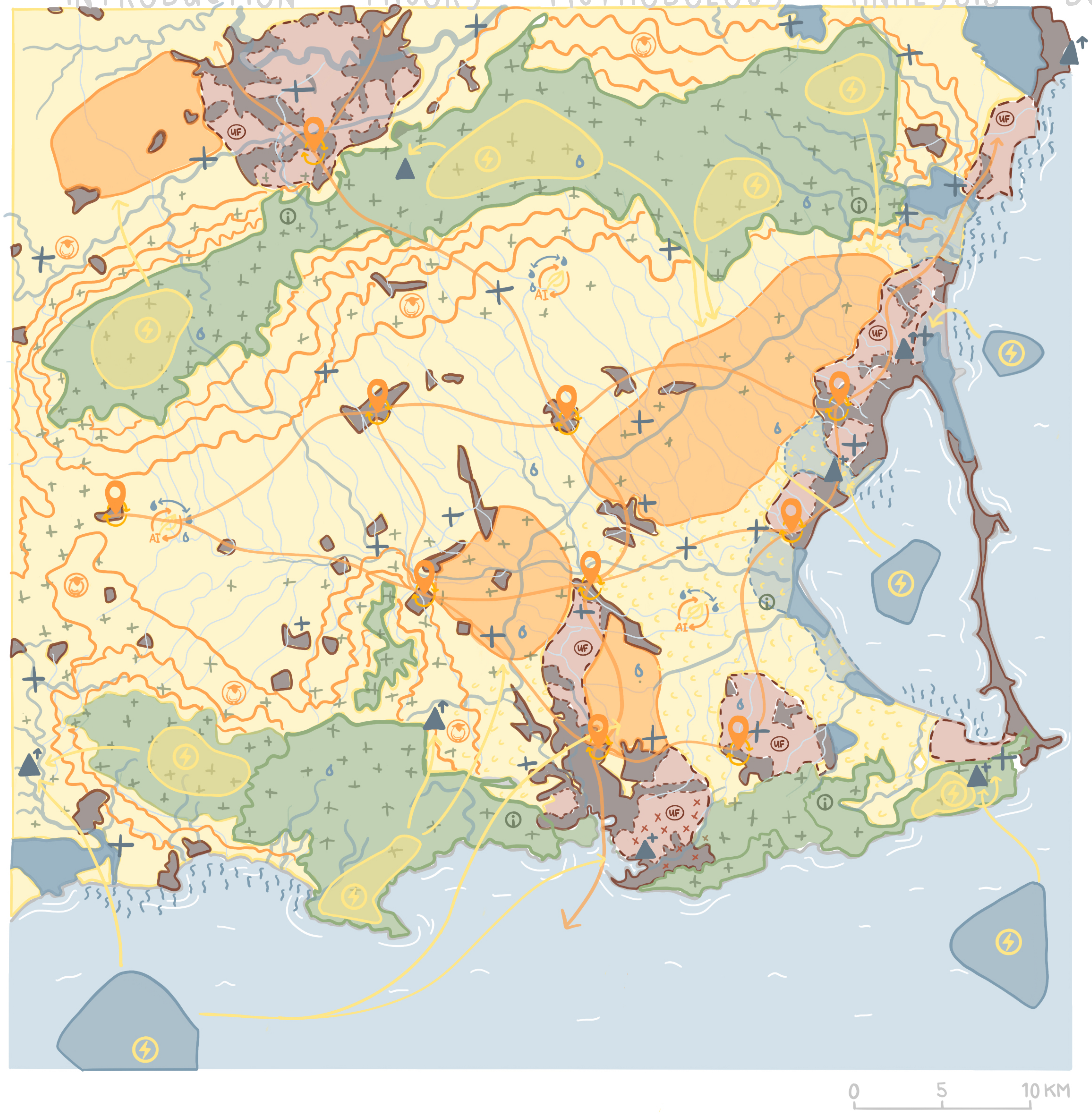


SCENARIO 2

SELF—SUFFICIENCY







SCENARIO 3

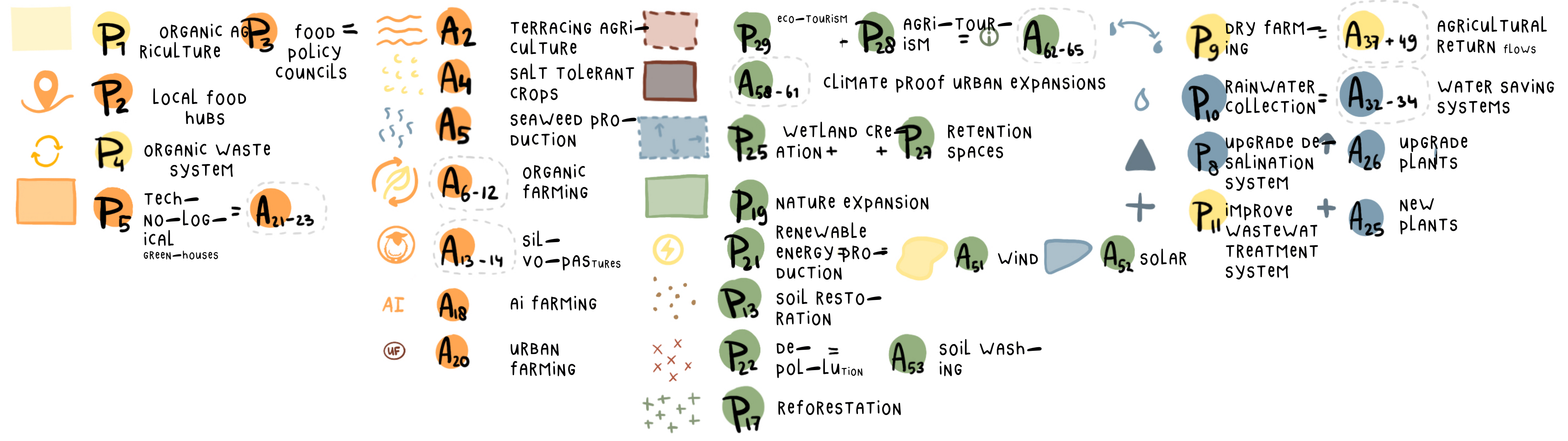
INNOVATIVE PRODUCTION

IMPORTANCE

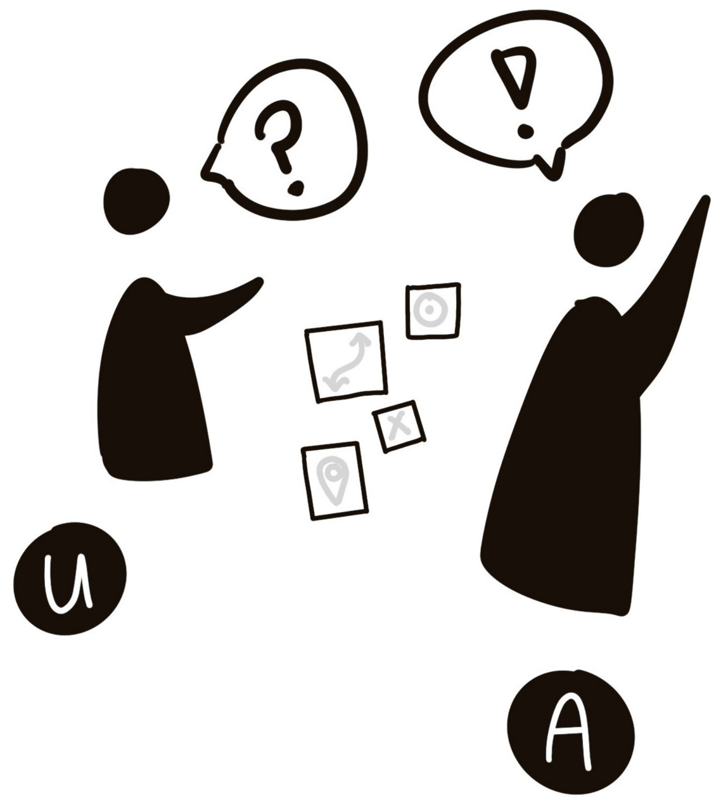
G_4 R_3 $P_2 + P_3 + P_4 + P_5 \rightarrow$ A_{15} A_{16} A_{17} A_{18} A_{19} A_{20} A_{21} A_{22} A_{23}

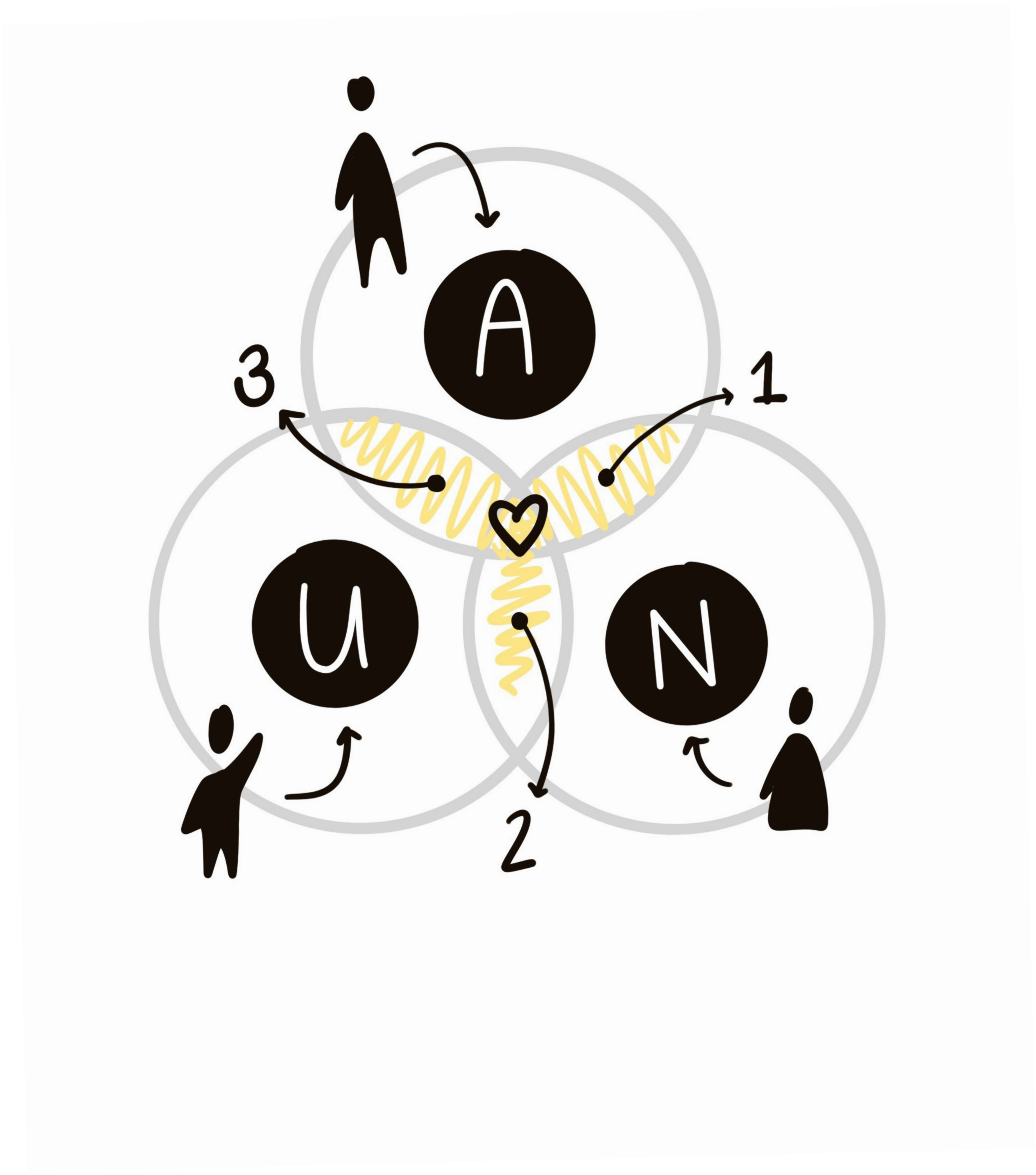
G_2 R_5 R_6 $P_8 + P_{11} + P_{10} \rightarrow$ A_{25} A_{26} A_{35} A_{36} A_{32} A_{33} A_{34}

G_3 R_{12} R_{13} $P_{21} + P_{26} + P_{27} + P_{29} \rightarrow$ A_{51} A_{52} A_{17} A_{54} A_{58} A_{59} A_{60} A_{61} A_{65}



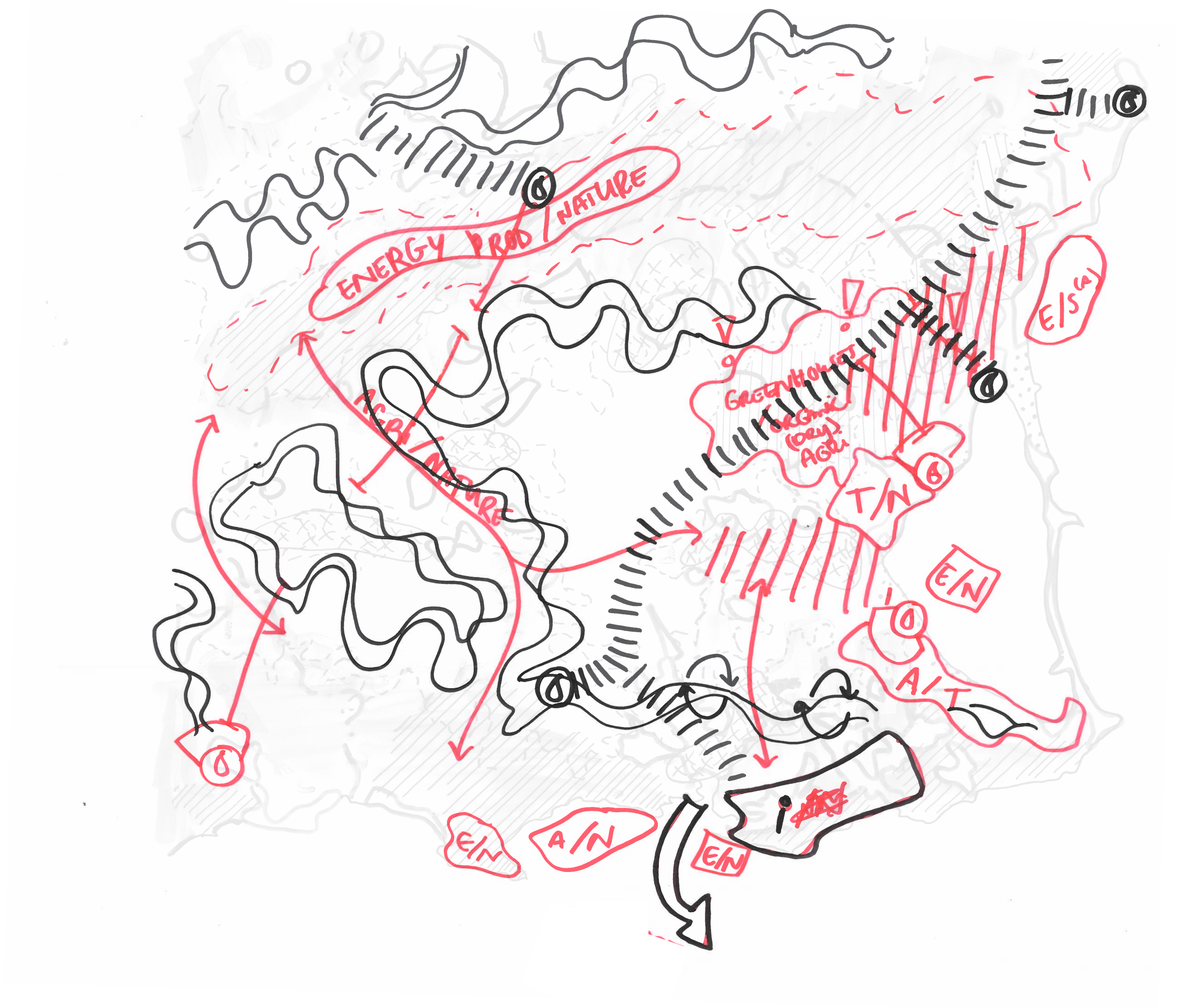
SECTOR SYMBIOSIS





A

A = A-N + U-A



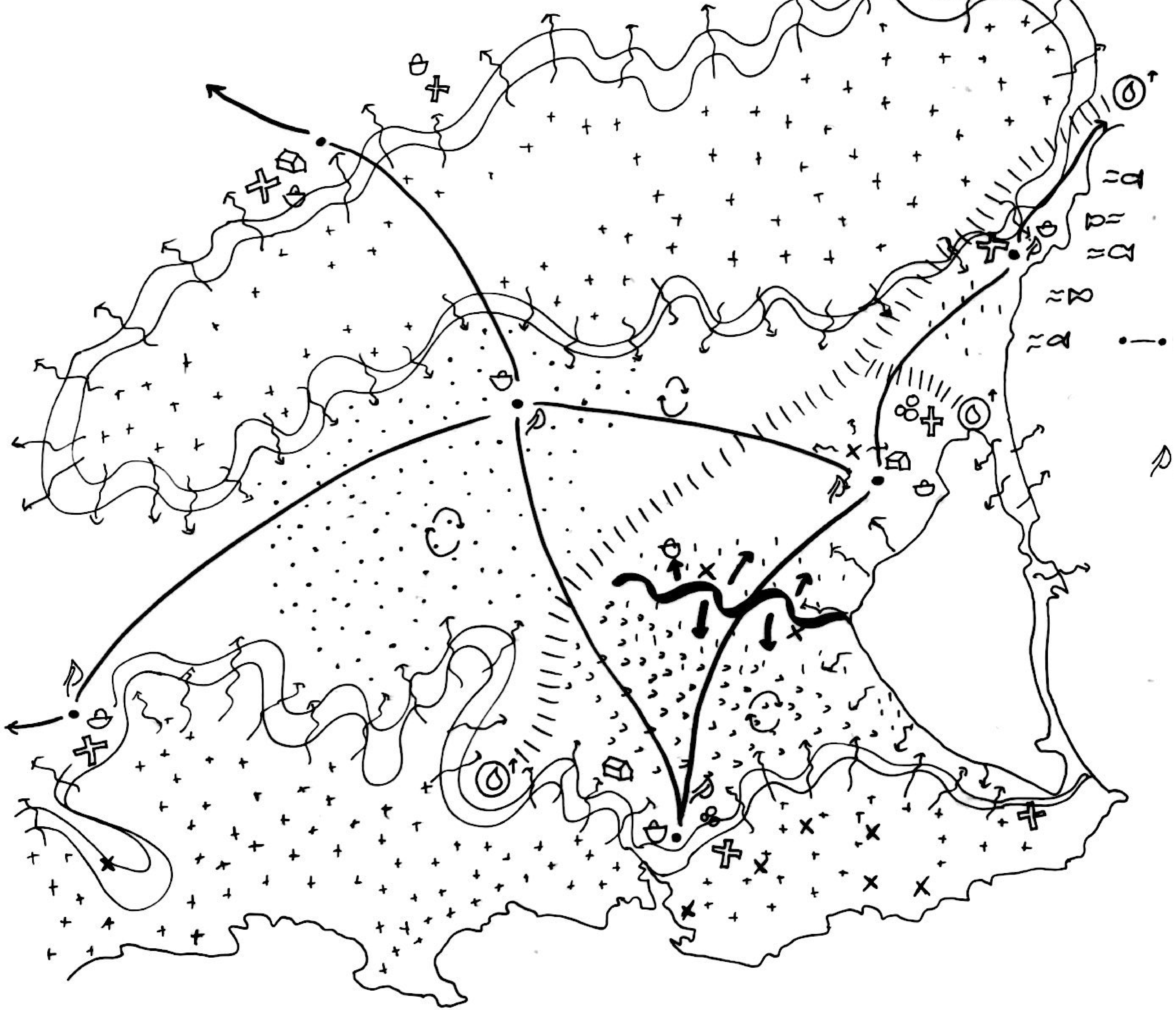
U

U = U-A + N-U

N

N = N-U + A-N

SYMBIOTIC & NO-REGRET MEASURES



P2 LOCAL FOOD PROCESSING & DISTRIBUTION HUBS
- A19 FARMER MARKETS
- A20 URBAN FARMING

P4 CENTRALISED ORGANIC WASTE COLLECTION

P8 IMPROVE THE DESALINATION NETWORK
- A24 TRANSFORM TST INFRASTRUCTURE
- A26 EXPAND DESALINATION PLANTS

P10 CENTRALISED RAINWATER COLLECTION NETWORK
- A37 AGRICULTURE RETURN FLOWS

P11 WASTEWATER TREATMENT NETWORK
- A35 WASTEWATER TREATMENT PLANTS
- A36 ALGAE MATERIAL HUB

P7 TRANSFORM TO ORGANIC AGRICULTURE
- A1 DROUGHT TOLERANT CROPS
- A2 TERRACING
- A3 TRANSITION PARCALS TO NATURE
- A4 SALT TOLERANT CROPS
- A5 SEAWEED FARMING

P17 REFORESTATION

P22 SOIL & WATER DECONTAMINATION
- A55 PHYTOEXTRACTION
- A56 PHYTOSTABILISATION

P26 EXPAND RAMBLAS

Figure 61. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.

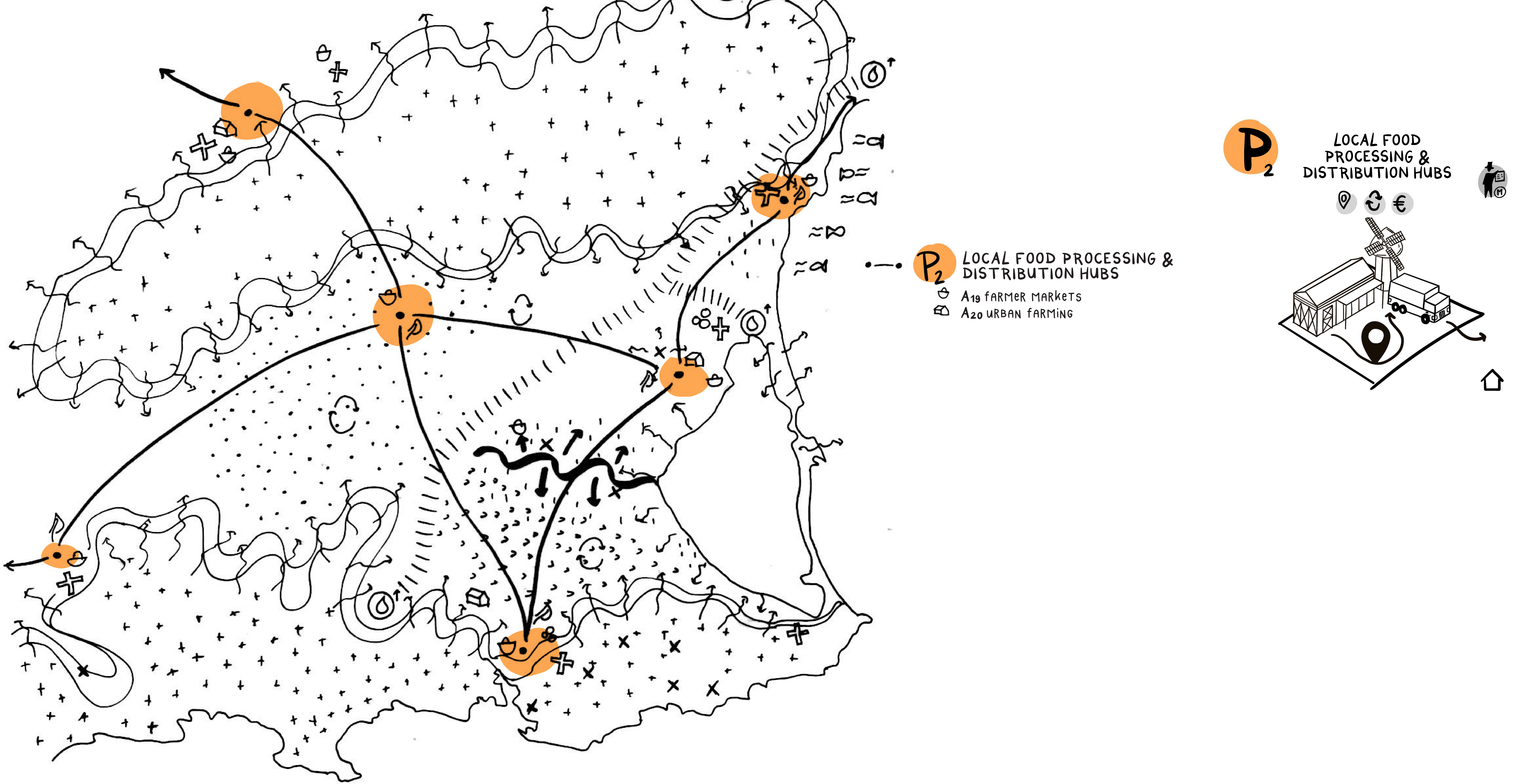


Figure 62. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.

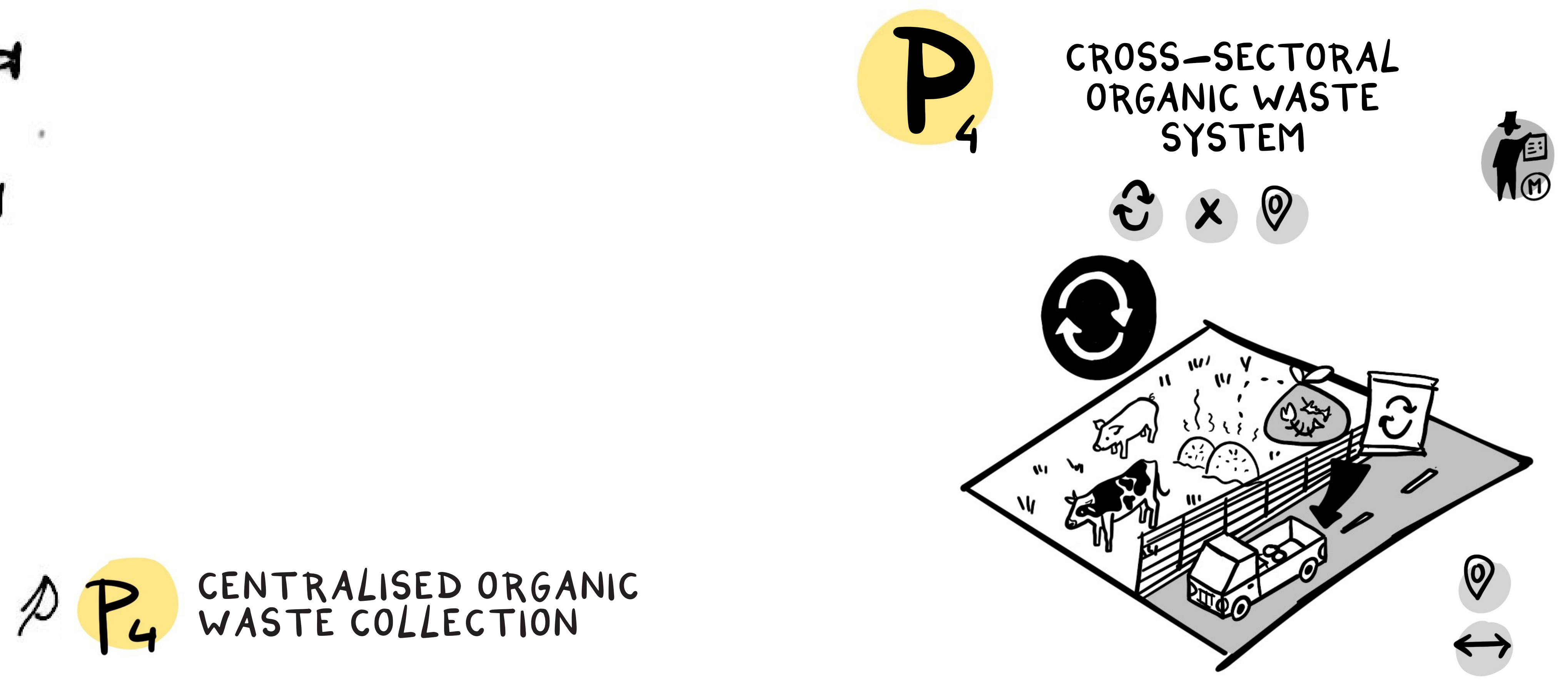
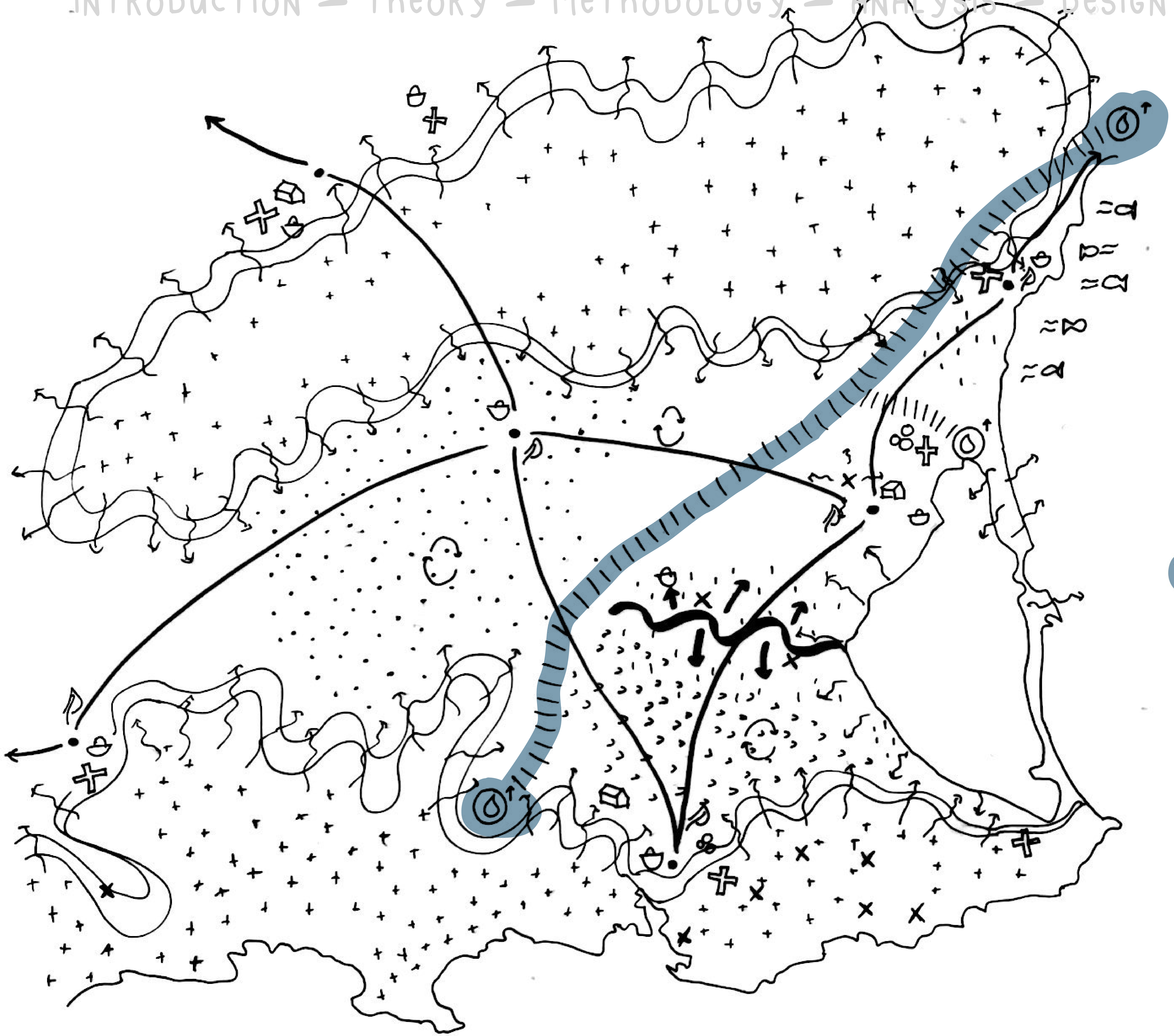
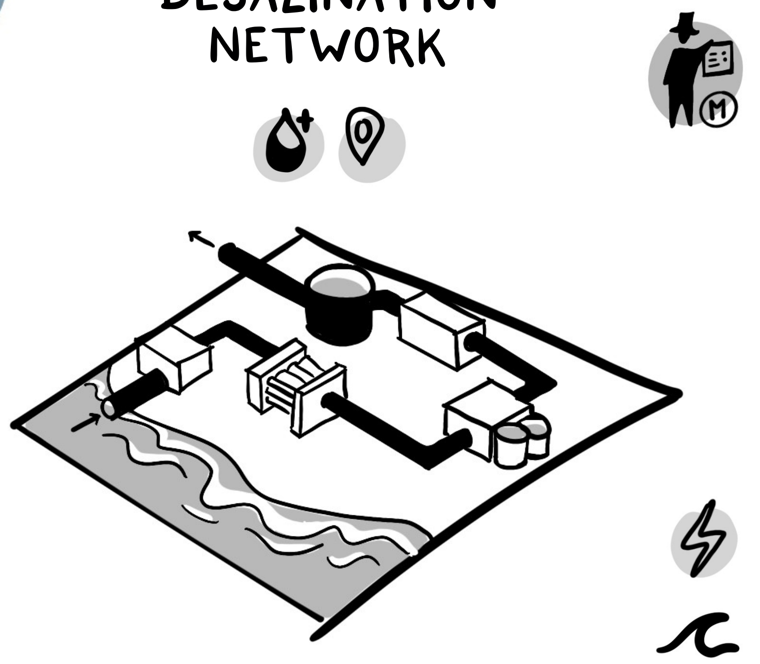


Figure 63. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.



P8 REGIONAL DESALINATION NETWORK

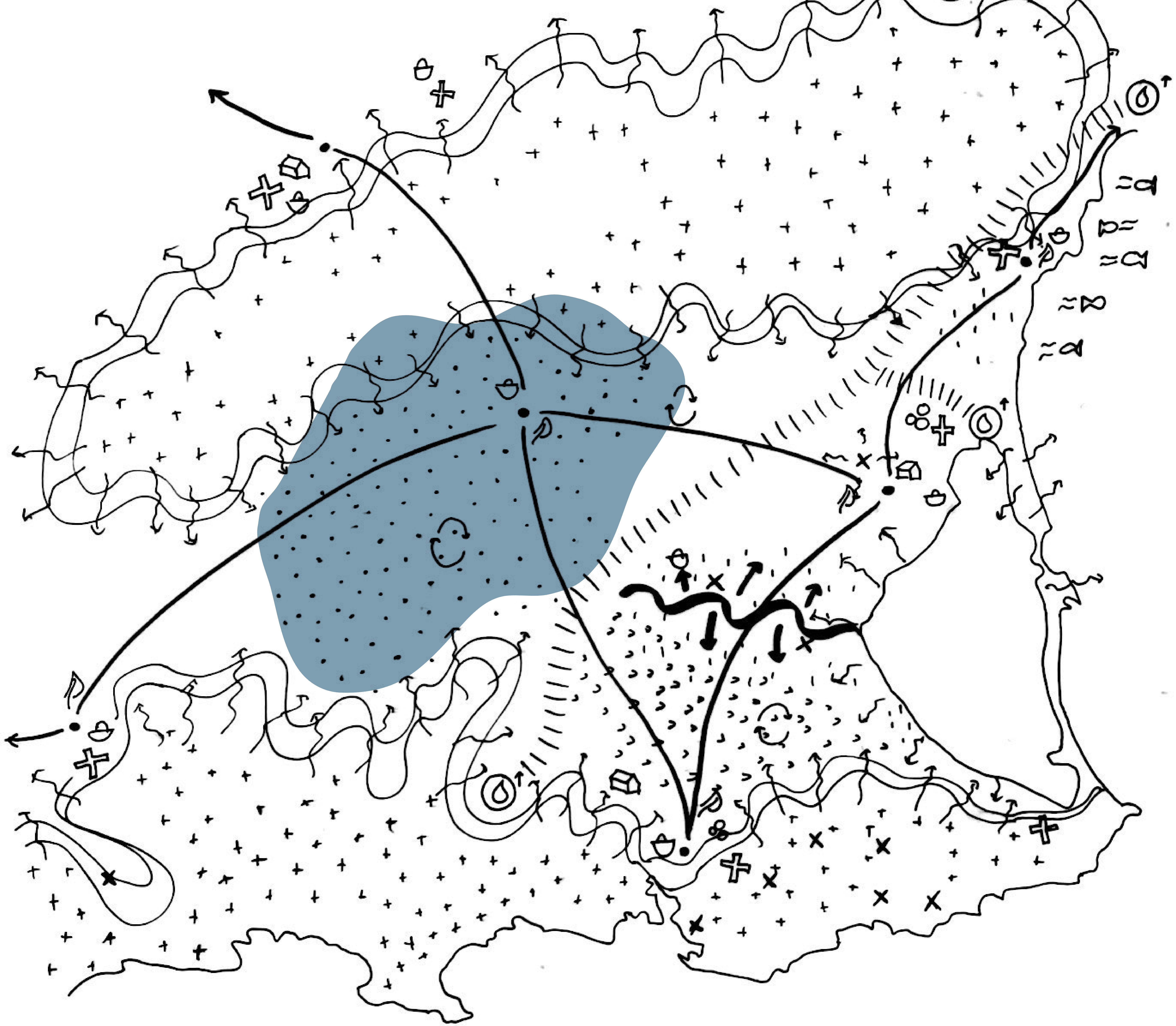


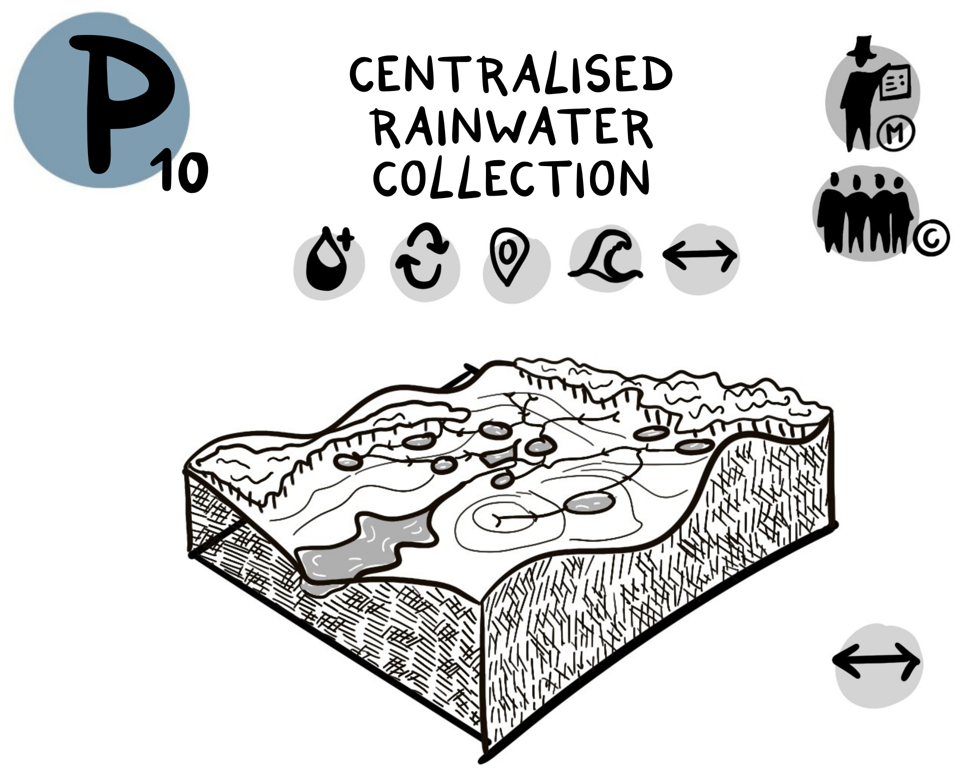
P8 IMPROVE THE DESALINATION NETWORK

A24 TRANSFORM TST iNFRASTRUCTURE

A26 eXPAND DESALiNATiON pLANTS

Figure 64. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.





P10 CENTRALISED RAINWATER COLLECTION NETWORK

- A29 DiTChes SYSTeM
- A37 AGRiCULTURAL ReTURN FLOWS
- A33 RAiNWATER BARReLS
- A34 UNDERGROUND TANKS

Figure 65. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.

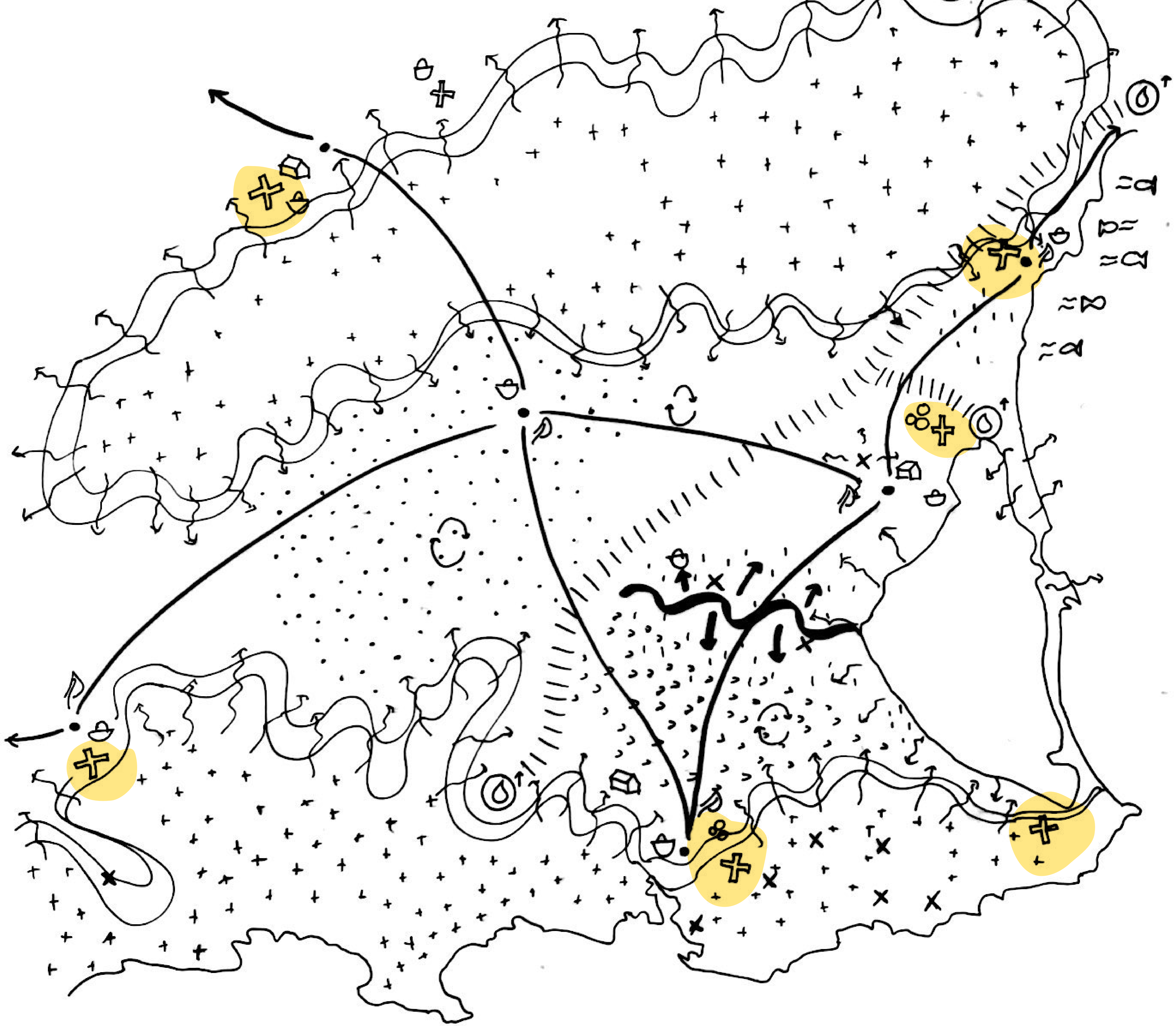
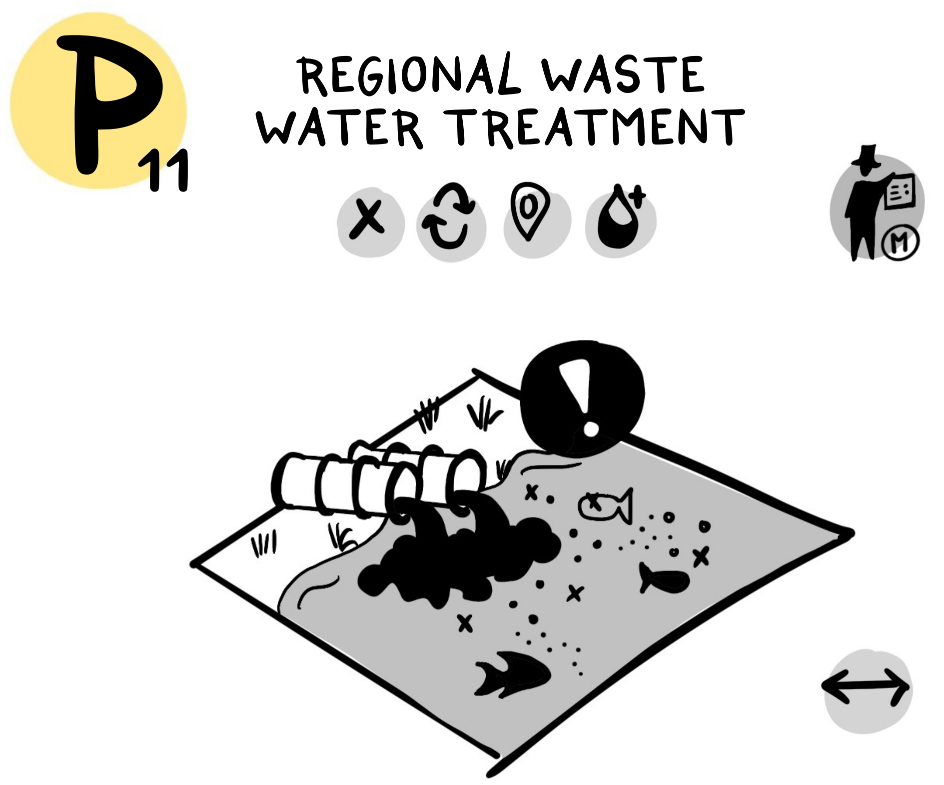


Figure 66. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.

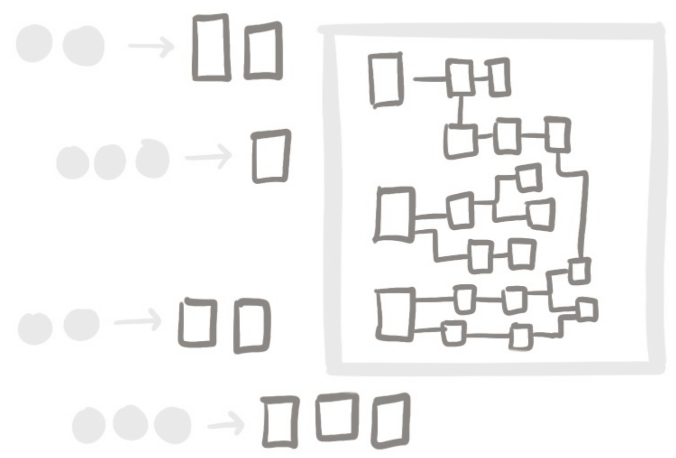


P 11 WASTEWATER TREATMENT NETWORK

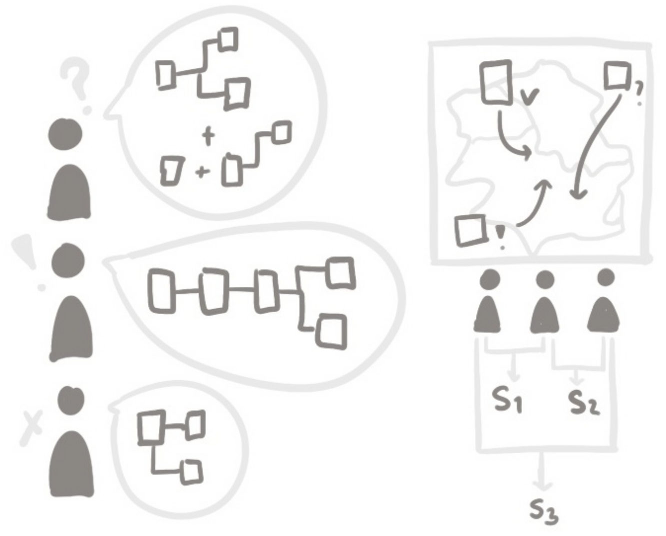
- A35 WASTEWATER TREATMENT PLANTS
- A36 ALGAE MATERIAL HUB

design

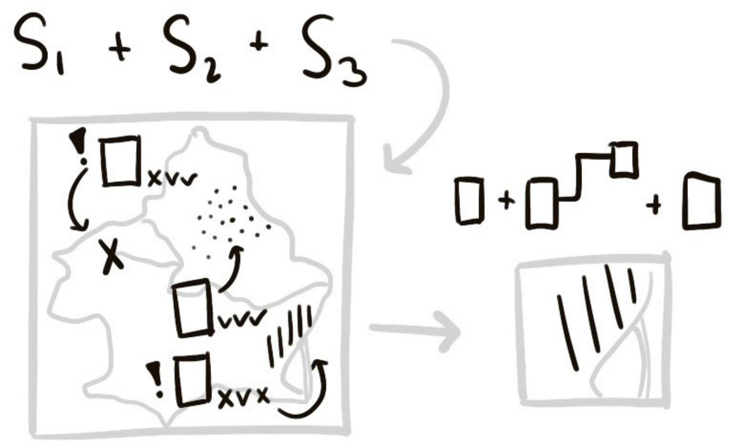
STEP 1



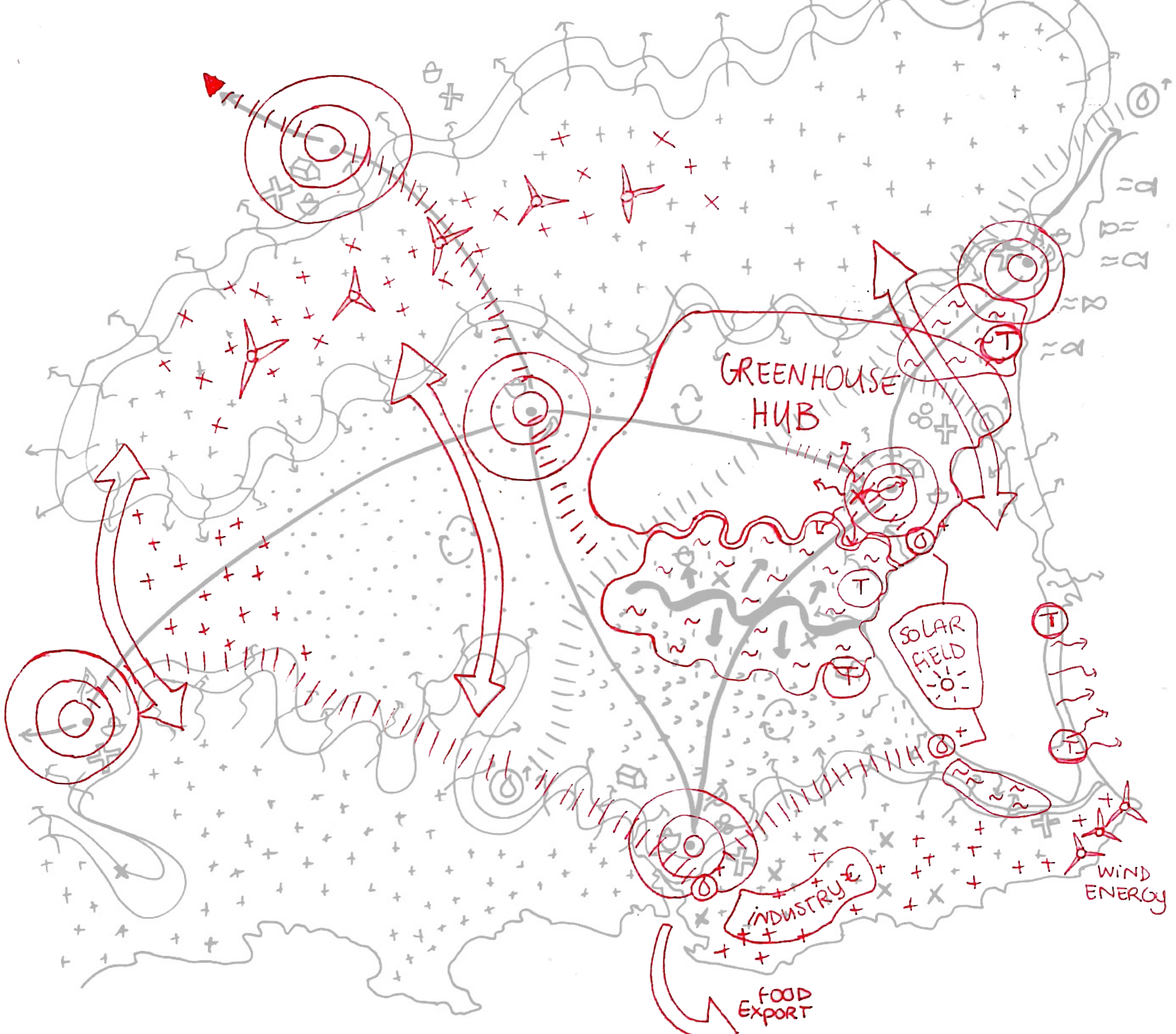
STEP 2



STEP 3



SPATIAL CONFLICT



- P18 = ecological corridor
- P2 = local food production zones of dry agriculture
- P21 = wind energy production
- P21 = solar farms
- P17 = reforestation & soil treatment
- P22 = phytoremediation + carbon sequestration
- P19 = expand protected nature areas
- P8 = desalination plants (new)
- P8 = desalination infrastructure
- P5 = greenhouse hub
- P25 = create wetland and water retention areas
- P29 = agrotourism and urban expansions

Figure 67. Map of the interventions causing spatial conflict when comparing all scenarios spatially. Source: made by author.

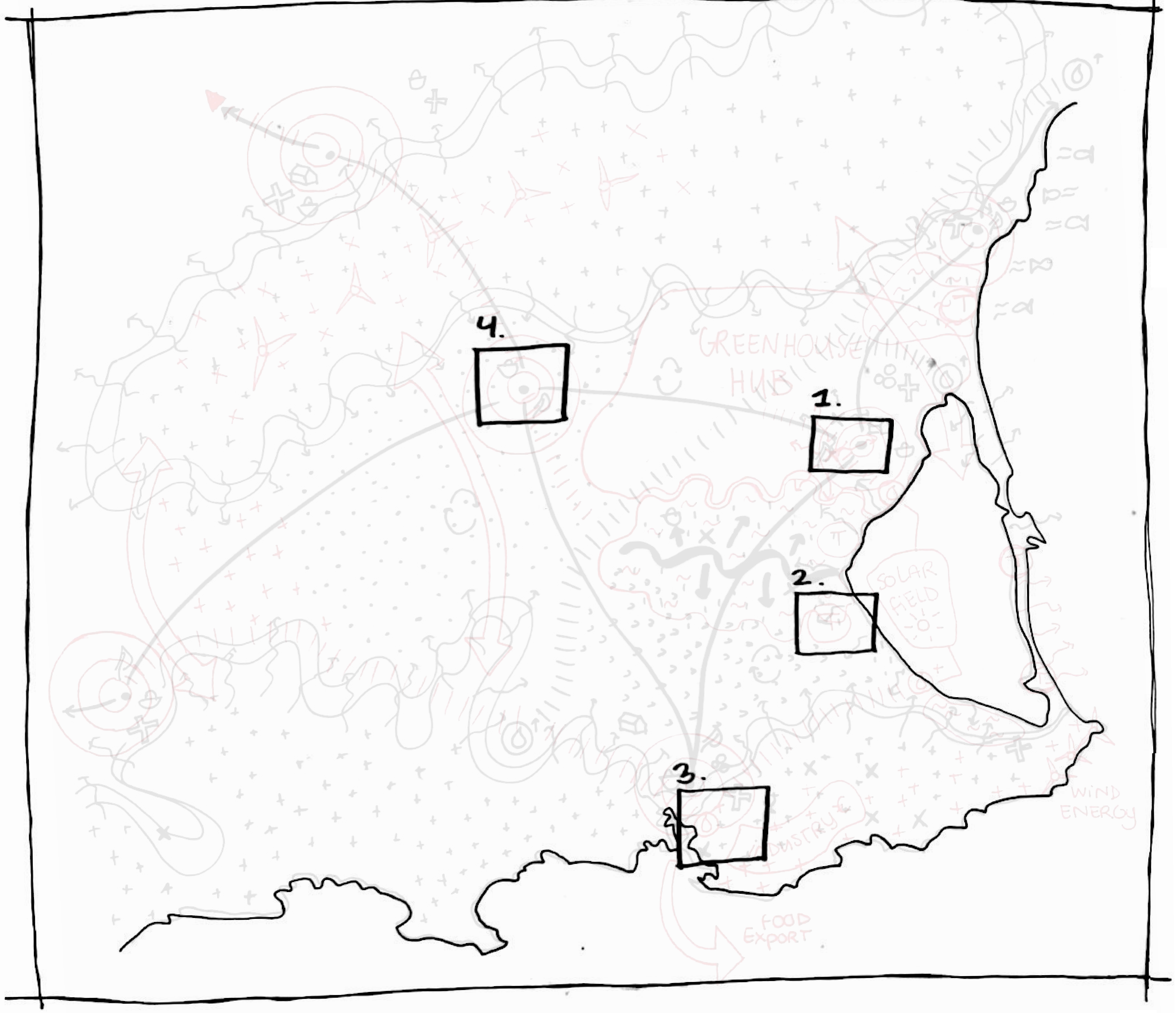


Figure 68. Areas of spatial intervention conflict from overlapping the scenarios. Source: made by author.

STRATEGIC PROJECTS

FROM AREAS OF SPATIAL CONFLICT TO STRATEGIC PROJECTS:

1. PILOT GREENHOUSE HUB

COMBiNiNG TeChNOLOGiCAL iNNOVATiON iN The fOOD iNDUSRY & JUSTiCe fOR NATURe

2. ECOTOURISM WETLAND

COMBiNiNG DePOLLUTiON, eCOLOGiCAL fLOW ReSTORATiON AND hABiTAT PROTeCTiON & TOURiSM

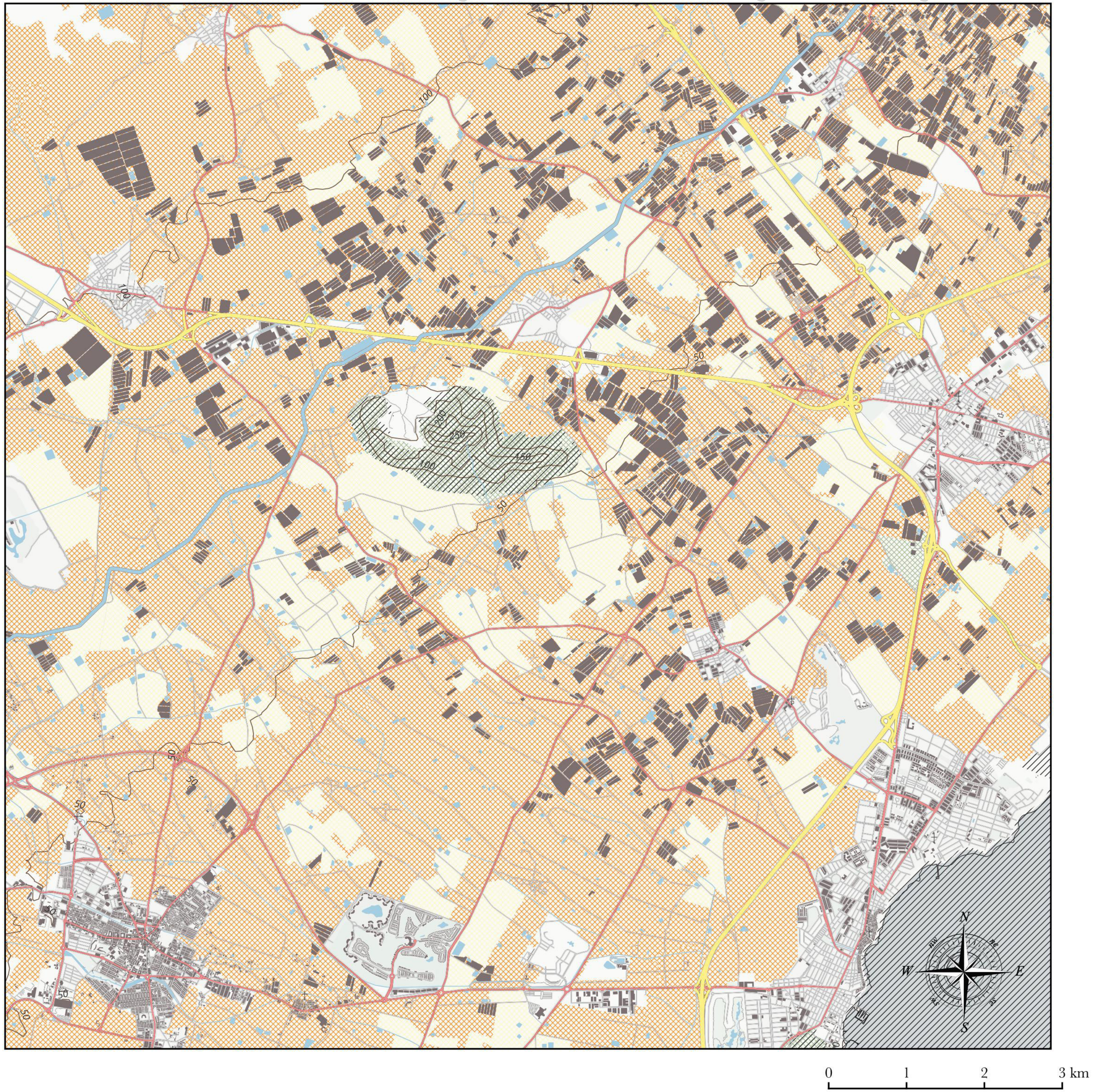
3. TRANSITION OF THE HARBOUR

COMBiNiNG ReNeWABLe WATeR AND eNeRGY PRODUCTiON & CLiMATe ReSiLieNT URBAN DeVeLOPMeNT

4. DETACHED SYSTEMS

COMBiNiNG fOOD AND WATeR SeLf—SUffiCieNCY AND CO—MANAGeMeNT & iNDiGeNOUS TeChNiQUeS iN DeTAChED AGGLOMeRATiONS

BOTTOM—UP DESIGN APPROACH



STRATEGIC PROJECTS
LOCATION 1

SCENARIO 1

P1
TRANSITION TO ORGANIC AGRICULTURE

SCENARIO 2

P18
ECOLOGICAL CORRIDORS

P23
RIPARIAN BUFFER ZONES

P19
PROTECTED NATURE AREAS

P25
WETLAND AREAS

SCENARIO 3

P5
INNOVATIVE GREEN-HOUSE HUB

Legend

Buildings
Canal Tajo-S

Road network
Motorway or
Main road
Road, residential, living street, etc.

Waterways
Stream
River

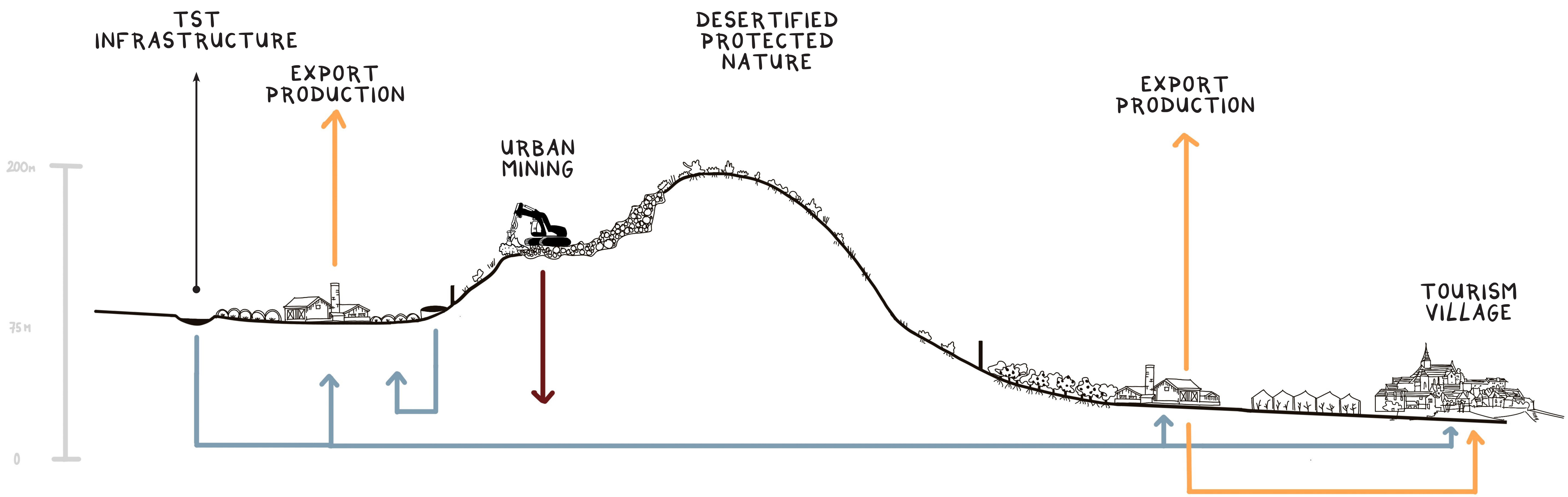
Water
Protected areas

Corine Land Cover 2018
212: Permanently irrigated land
222: Fruit trees and berry plantations
321: Natural grasslands
Elevation

Figure 69. Location strategic procject 1: cumulative analysis map. Source: made by author, based on (CHS, 2025) and (CORINE, 2022).

STRATEGIC PROJECT LOCATION

CURRENT SITUATION



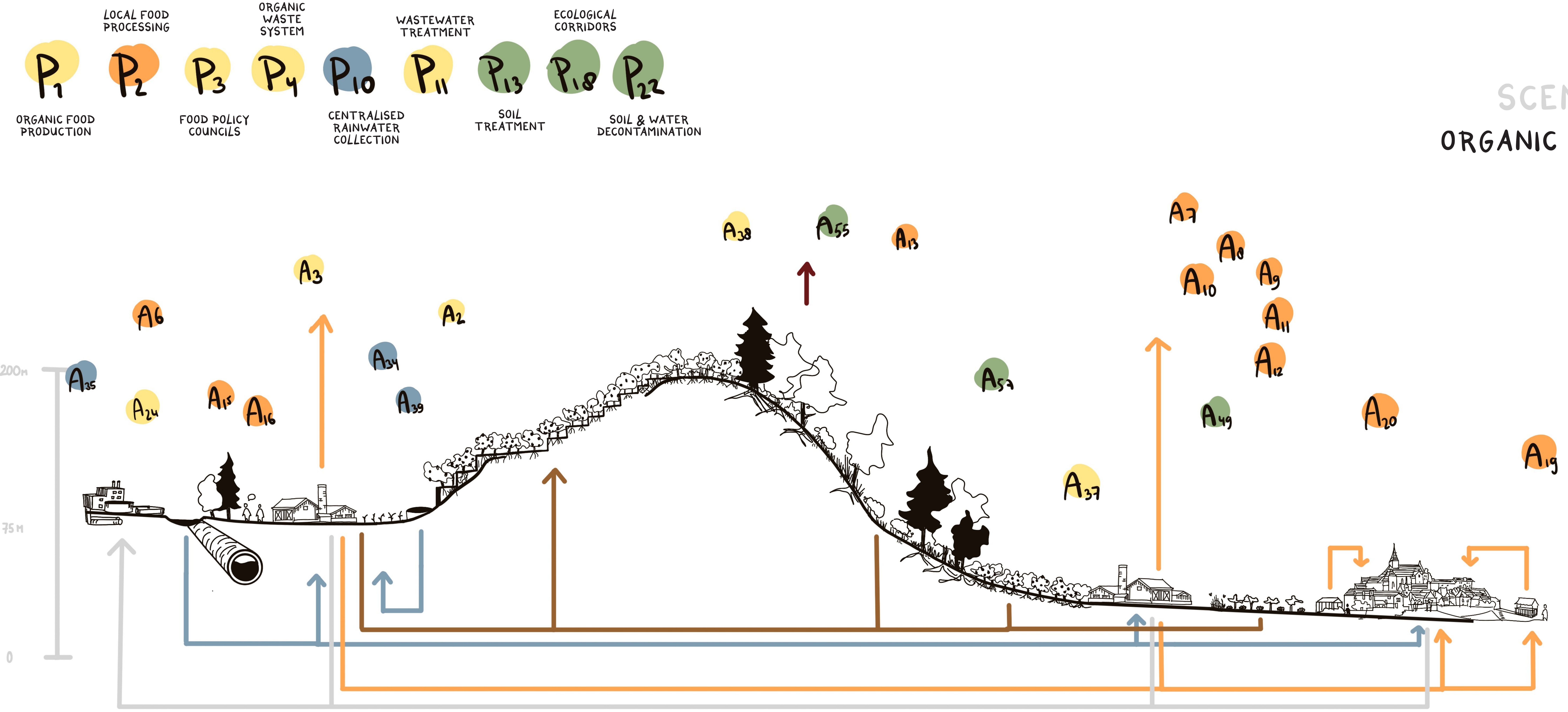
Legend of flows:

- = water supply
- = greywater
- = biochar
- = manure / organic mulch
- = pollution
- = food produce
- = energy

Figure 70. Section of the current practices and systems in location 1. Source: made by author.

SCENARIO 1

ORGANIC PRODUCE

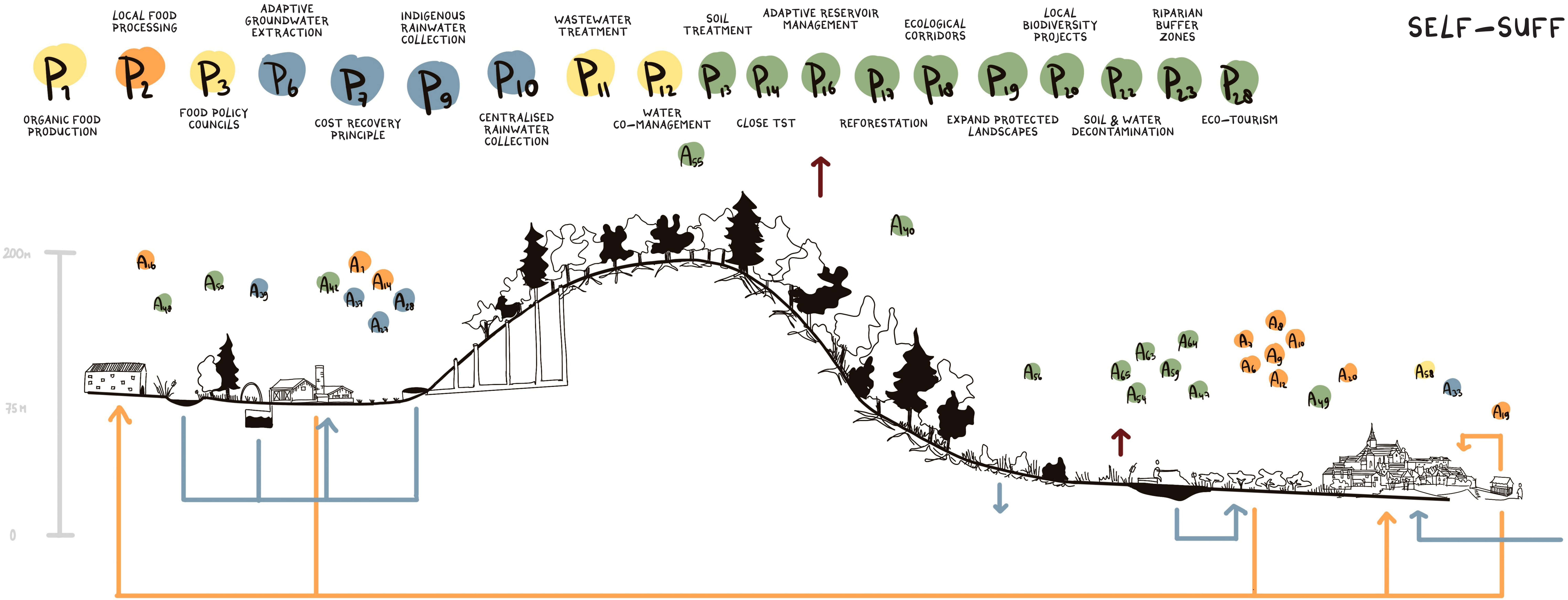


Legend of flows:

- = water supply
- = greywater
- = biochar
- = manure / organic mulch
- = pollution
- = food produce
- = energy

Figure 71. Section of the pattern selection for scenario 1 applied in location 1: practices and systems. Source: made by author.

SCENARIO 2
SELF-SUFFICIENCY



Legend of flows:

- = water supply
- = greywater
- = biochar
- = manure / organic mulch
- = pollution
- = food produce
- = energy

Figure 72. Section of the pattern selection for scenario 2 applied in location 1: practices and systems. Source: made by author.

SCENARIO 3

TECHNOLOGICAL FOOD–HUB

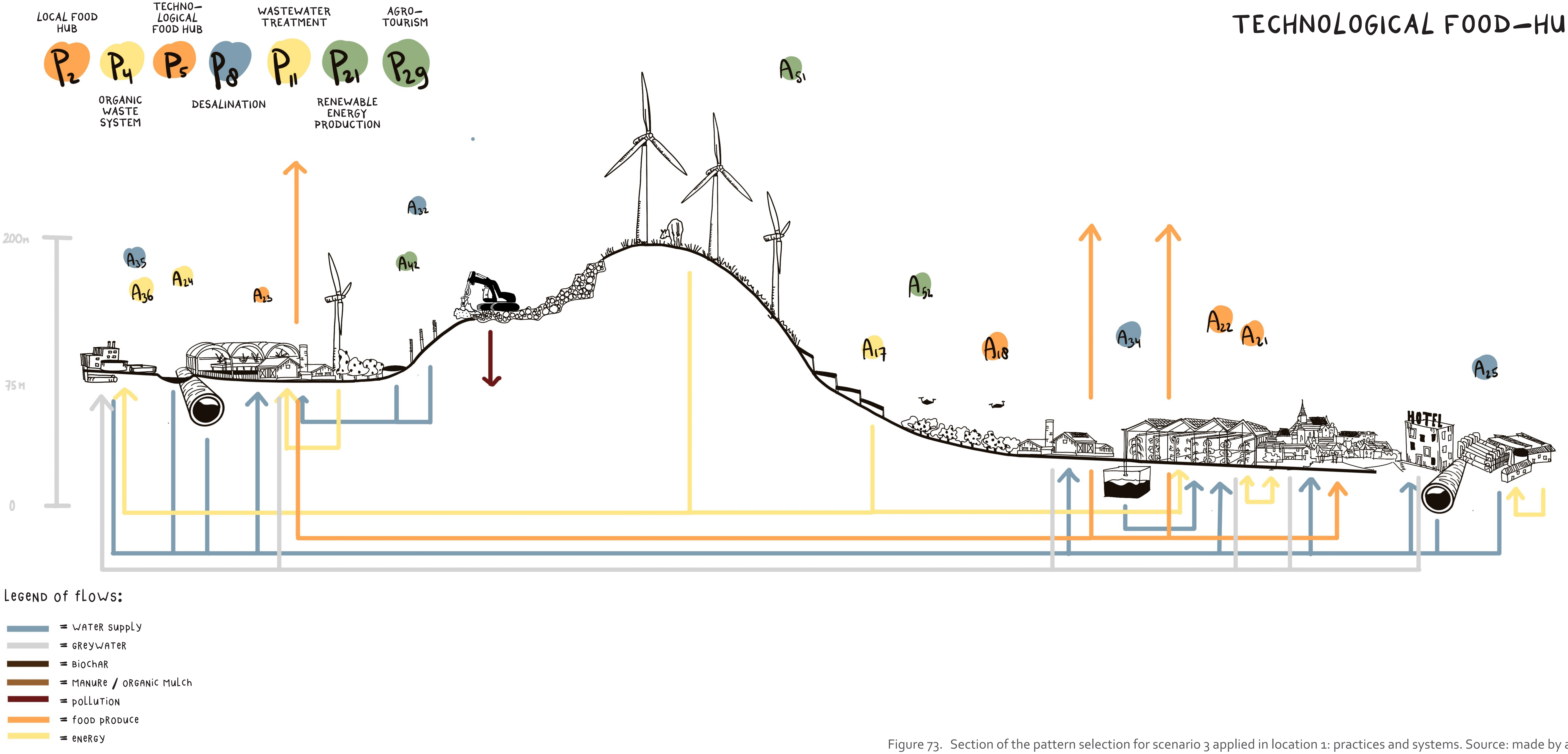
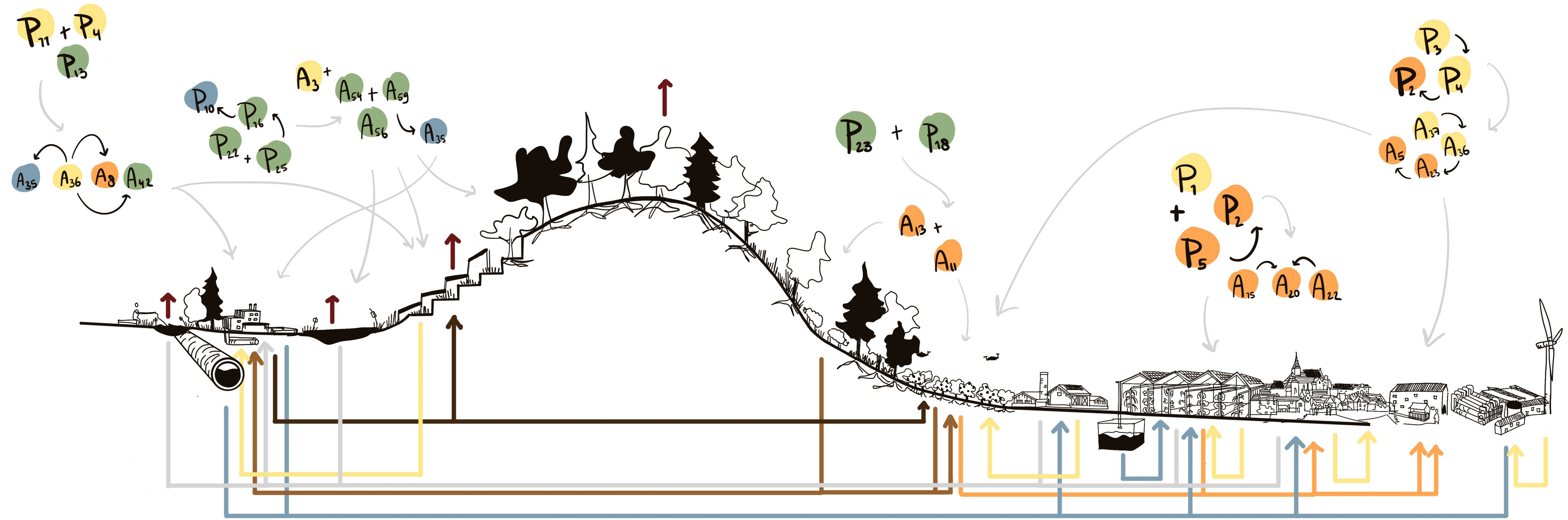


Figure 73. Section of the pattern selection for scenario 3 applied in location 1: practices and systems. Source: made by author.

SYMBIOTIC PATHWAY DESIGN

SCENARIO 4

PILOT HUB



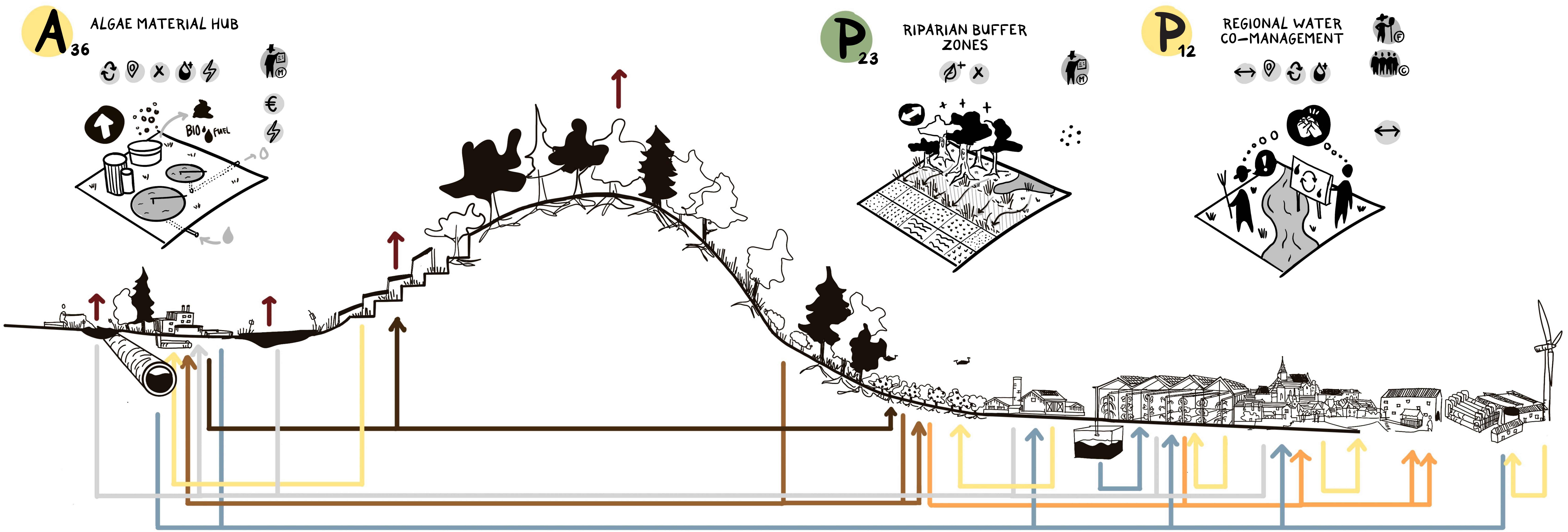
Legend of flows:

- = water supply
- = greywater
- = biochar
- = manure / organic mulch
- = pollution
- = food produce
- = energy

SYMBIOTIC PATHWAY DESIGN

SCENARIO 4

NEW PATTERNS



LeGeND Of fLOWS:

- = WATeR SUppLY
- = GReYWATeR
- = BiOchAR
- = MANURe / ORGANiC MuLch
- = poLLuTiON
- = fOOD pRODuCe
- = eNeRGY

Figure 74. Section of the pattern selection for scenario 4 - symbiotic pathway - applied in location 1: practices and systems. Source: made by author.

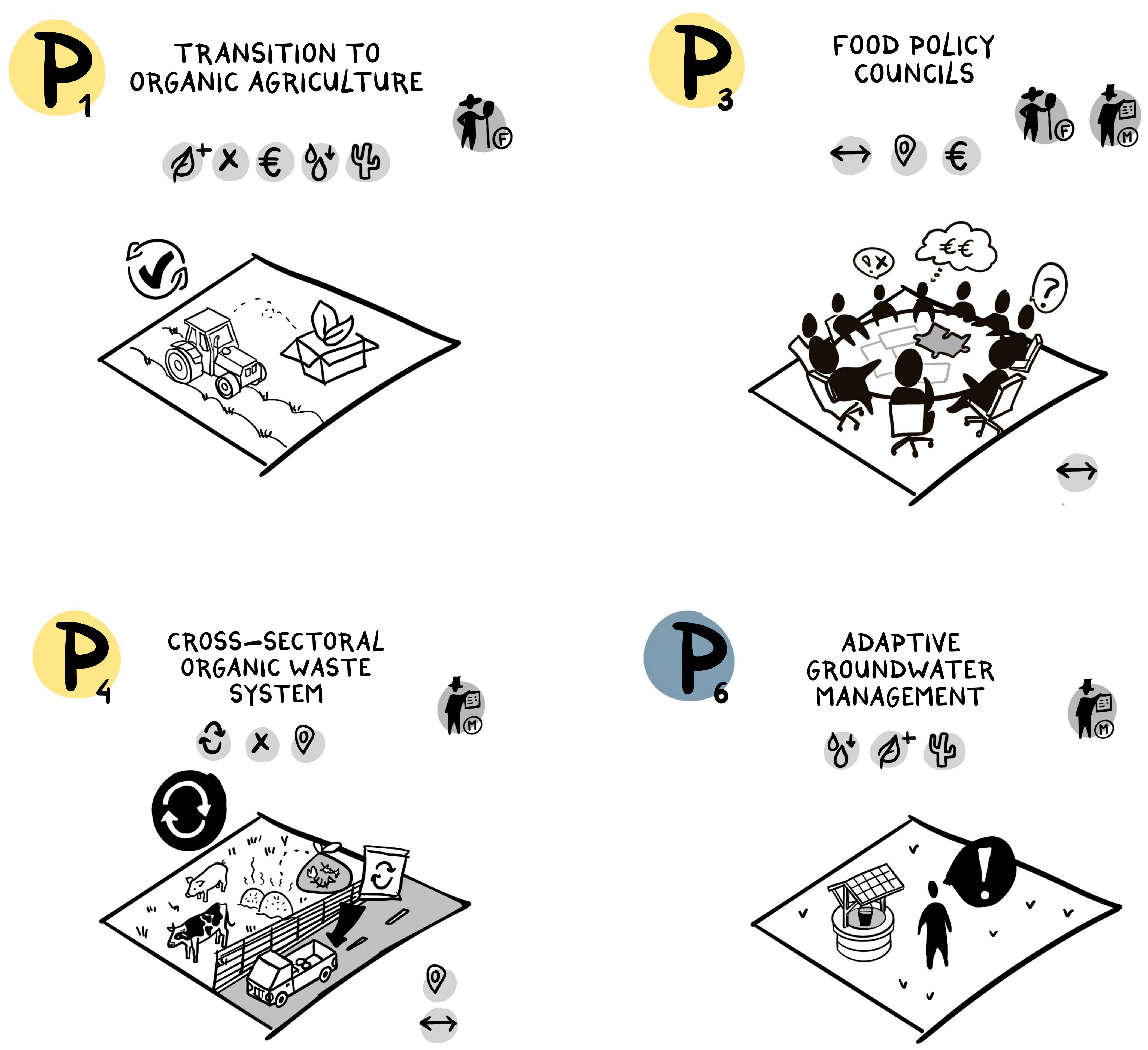
SYMBIOTIC PATHWAY DESIGN

SCENARIO 4

PILOT HUB

Figure 75. Section of the pattern selection for scenario 4 - symbiotic pathway - applied in location 1: practices and systems. Source: made by author.

SYMBIOTIC PATHWAY EXAMPLE
SCENARIO 4
CO-FARMING



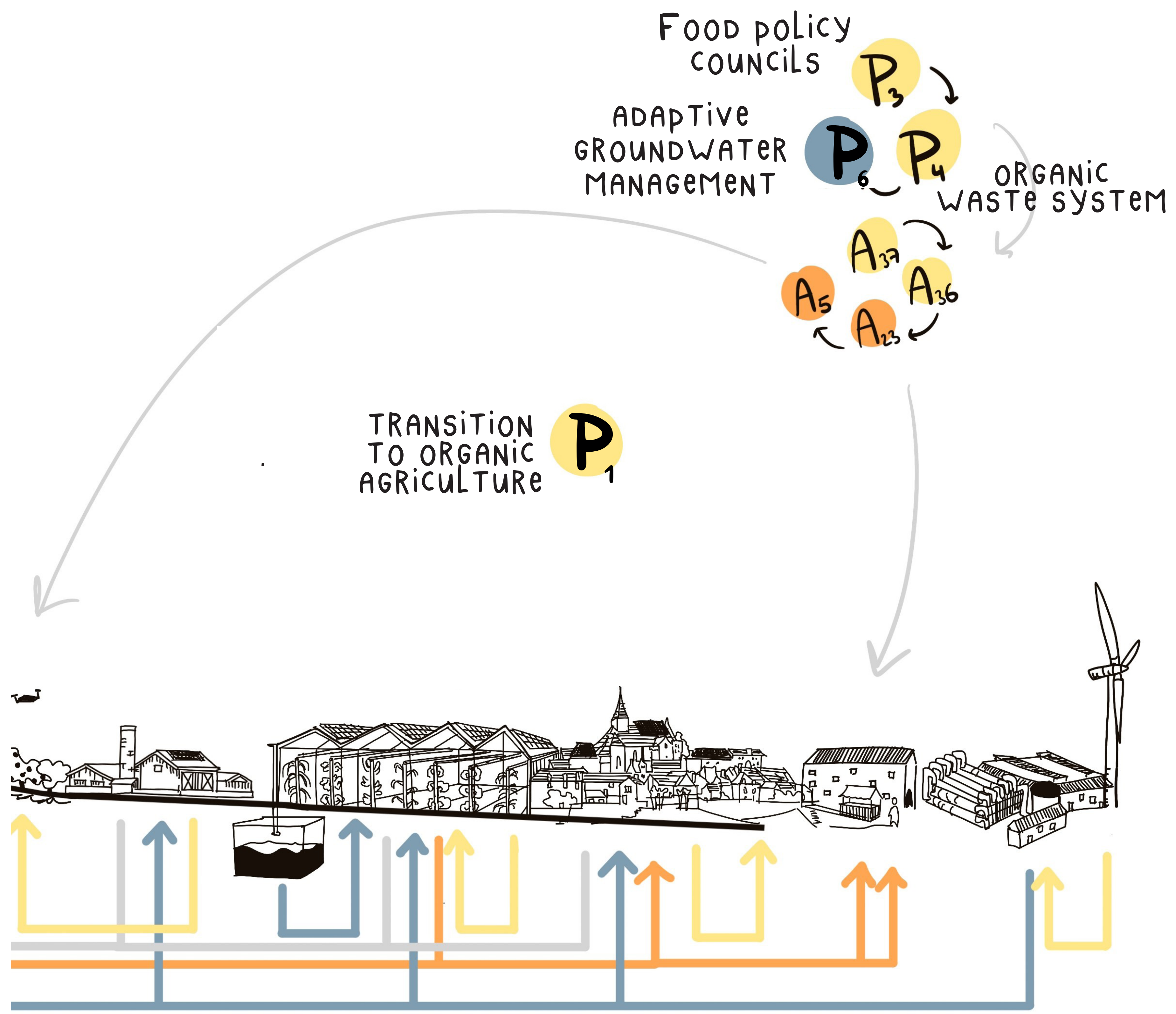


Figure 76. Symbiotic pathway design example scenario 4 - symbiotic pathway - for location 1. Source: made by author.

SYMBIOTIC PATHWAY EXAMPLE
SCENARIO 4
CO-FARMING

P1 TRANSITION TO ORGANIC AGRICULTURE

P3 FOOD POLICY COUNCILS

P4 CROSS-SECTORAL ORGANIC WASTE SYSTEM

P6 ADAPTIVE GROUNDWATER MANAGEMENT

SYMBIOTIC PATHWAY EXAMPLE

SCENARIO 4

LOCAL FOOD

P2 LOCAL FOOD PROCESSING & DISTRIBUTION HUBS

P29 AGRITOURISM

P4 CROSS–SECTORAL ORGANIC WASTE SYSTEM

P27 WATER RETENTION IN URBAN LANDSCAPES

SYMBIOTIC PATHWAY EXAMPLE
SCENARIO 4
URBAN (SMART) FARMING

P3 FOOD POLICY COUNCILS

P5 TECHNOLOGICAL GREENHOUSE HUB

P29 AGRITOURISM

P21 RENEWABLE ENERGY PRODUCTION

SYMBIOTIC PATHWAY EXAMPLE

SCENARIO 4

ECOTOURISM AND CLEAN CORRIDORS

- P_{25} EXPAND WETLANDS
- P_{26} EXPAND RAMBLAS & FLOODPLAINS
- P_{28} ECO—TOURISM
- P_{22} SOIL & WATER DECONTAMINATION
- P_{18} ECOLOGICAL CORRIDORS

SYMBIOTIC PATHWAY DESIGN
SCENARIO 4
PILOT HUB

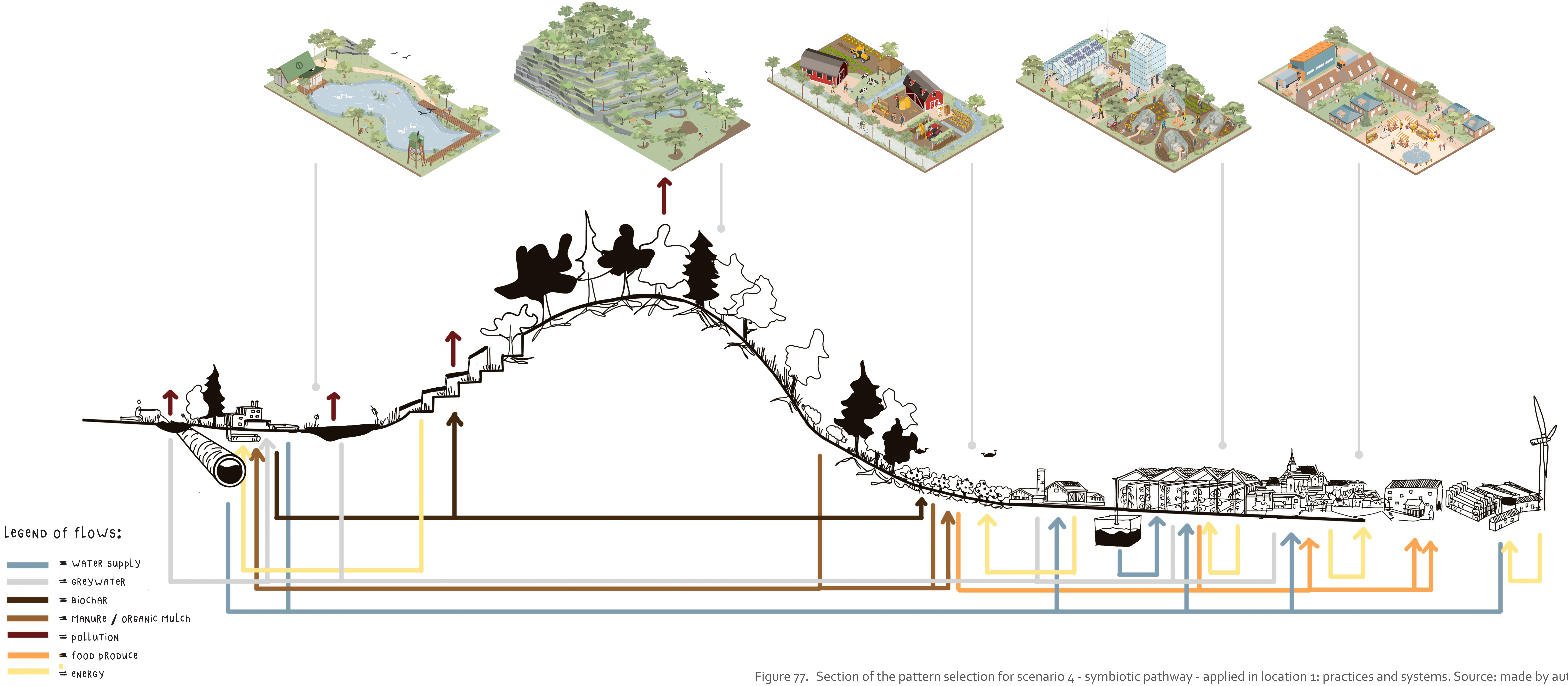
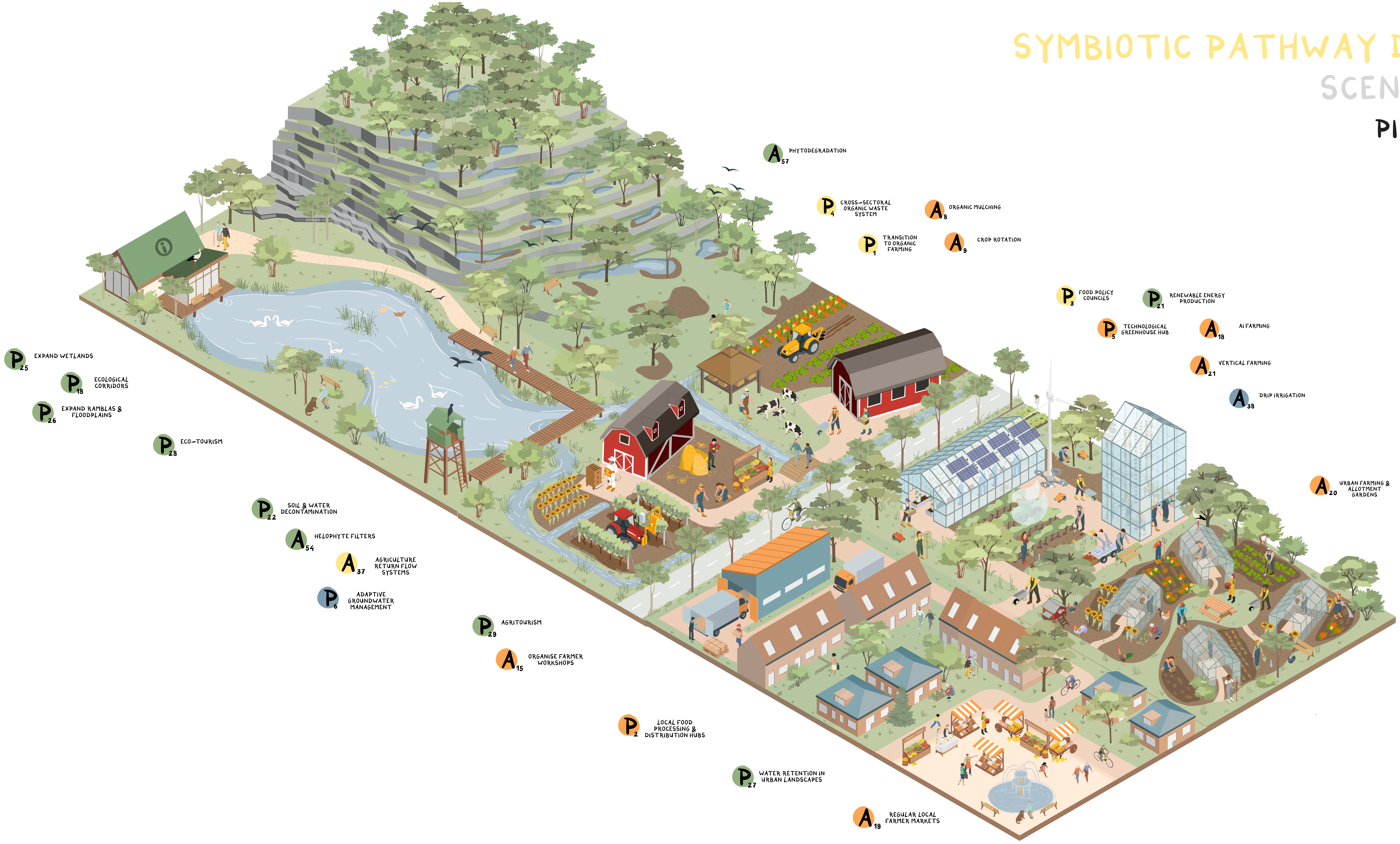


Figure 77. Section of the pattern selection for scenario 4 - symbiotic pathway - applied in location 1: practices and systems. Source: made by author.

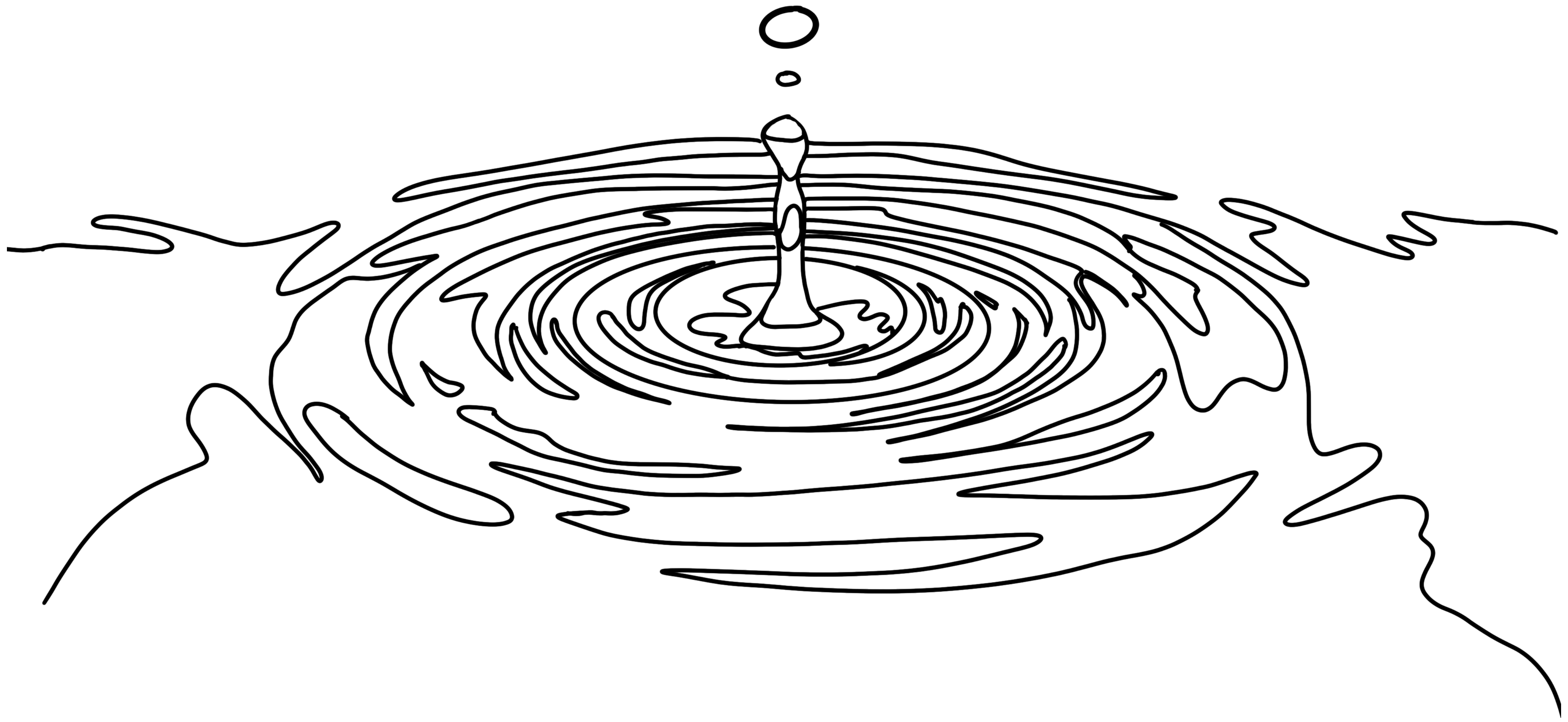
SYMBIOTIC PATHWAY DESIGN

SCENARIO 4

PILOT HUB

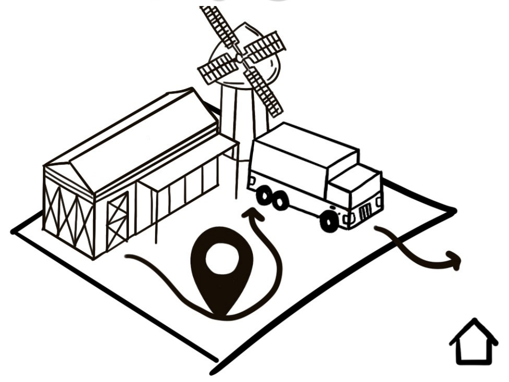


CONCLUSION



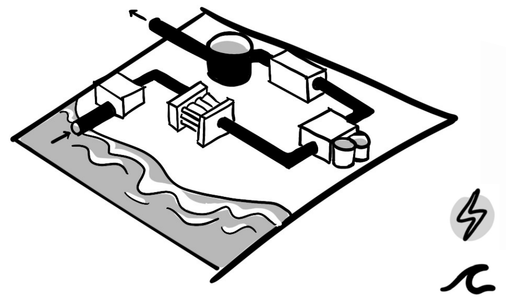
REGIONAL STRATEGY

P2
LOCAL FOOD PROCESSING & DISTRIBUTION HUBS

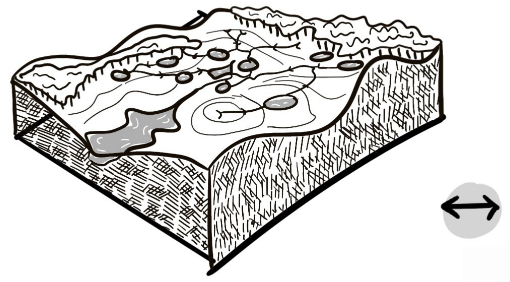


P4
CROSS-SECTORAL ORGANIC WASTE SYSTEM

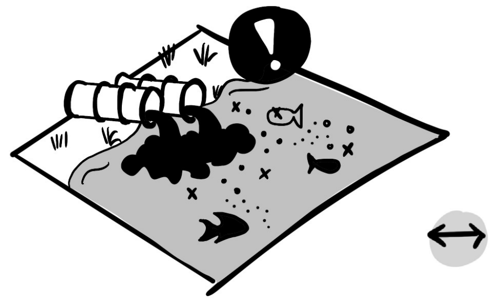
P8
REGIONAL DESALINATION NETWORK

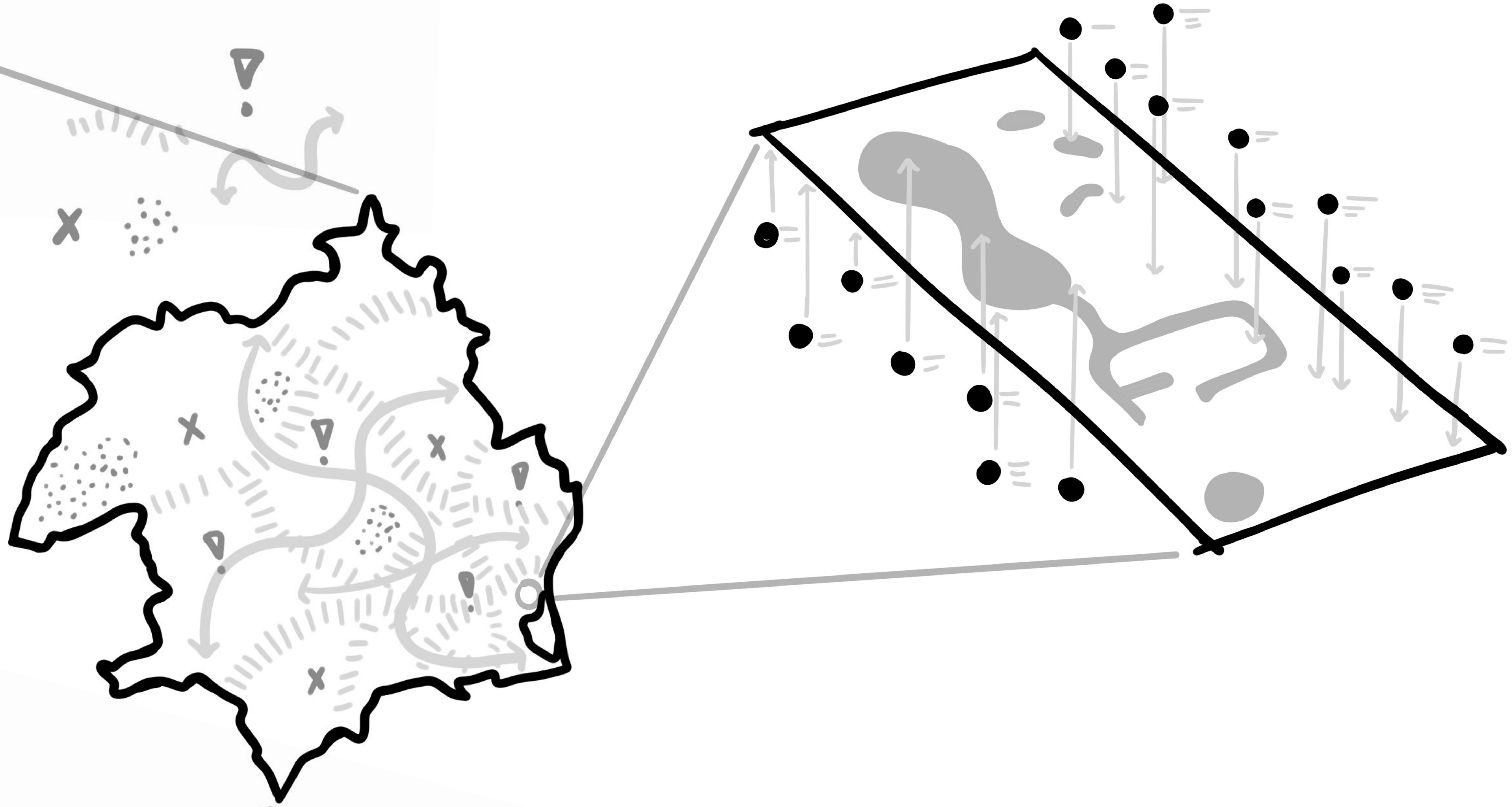


P10
CENTRALISED RAINWATER COLLECTION

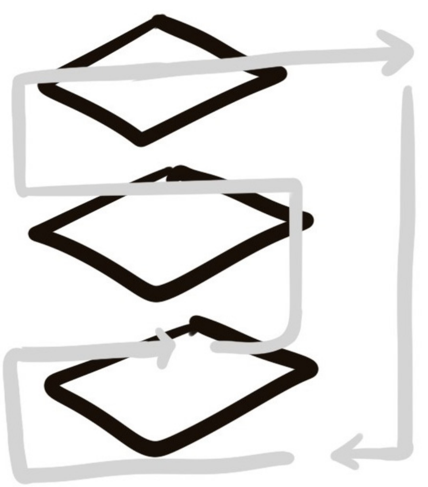


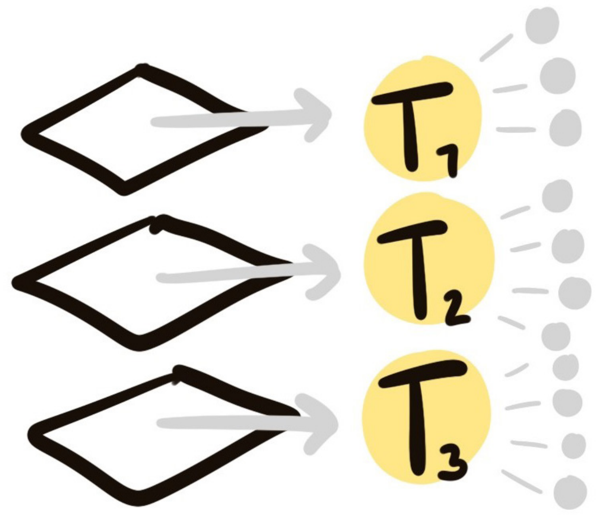
P11
REGIONAL WASTE WATER TREATMENT

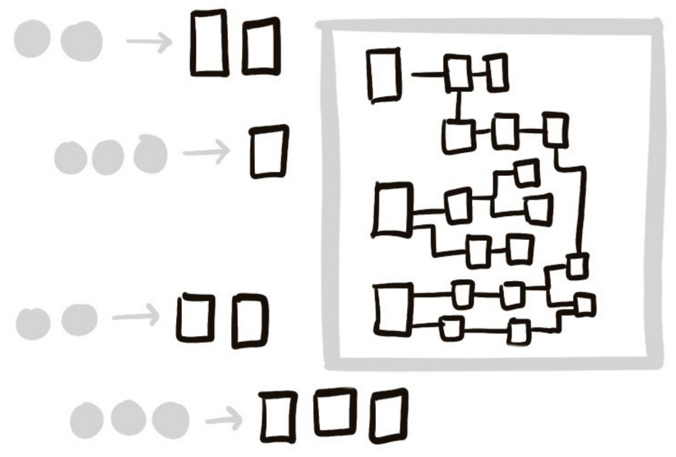


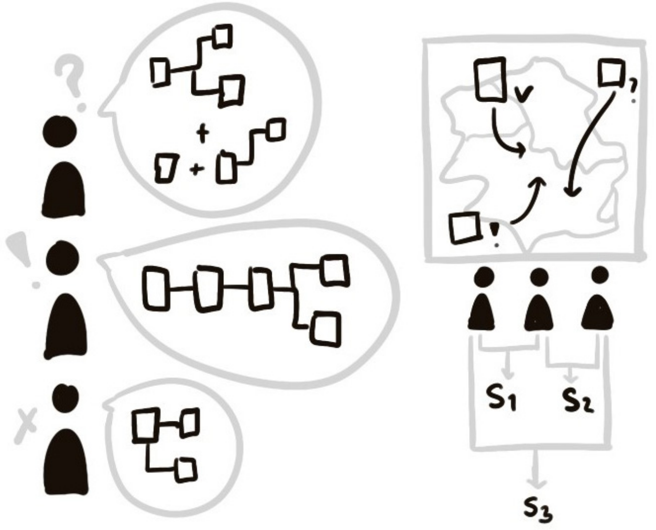


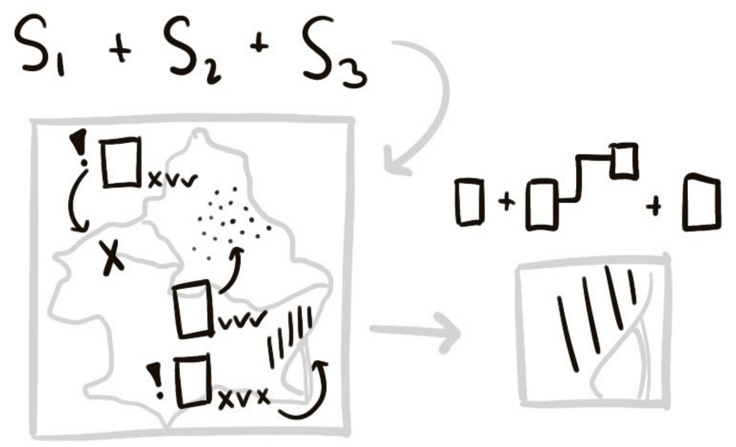
METHODOLOGICAL STEPS











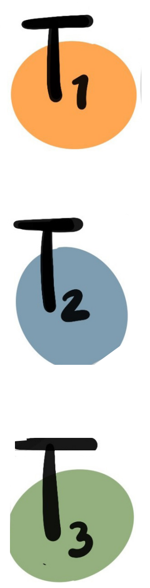
1 Integrated Systemic Analysis

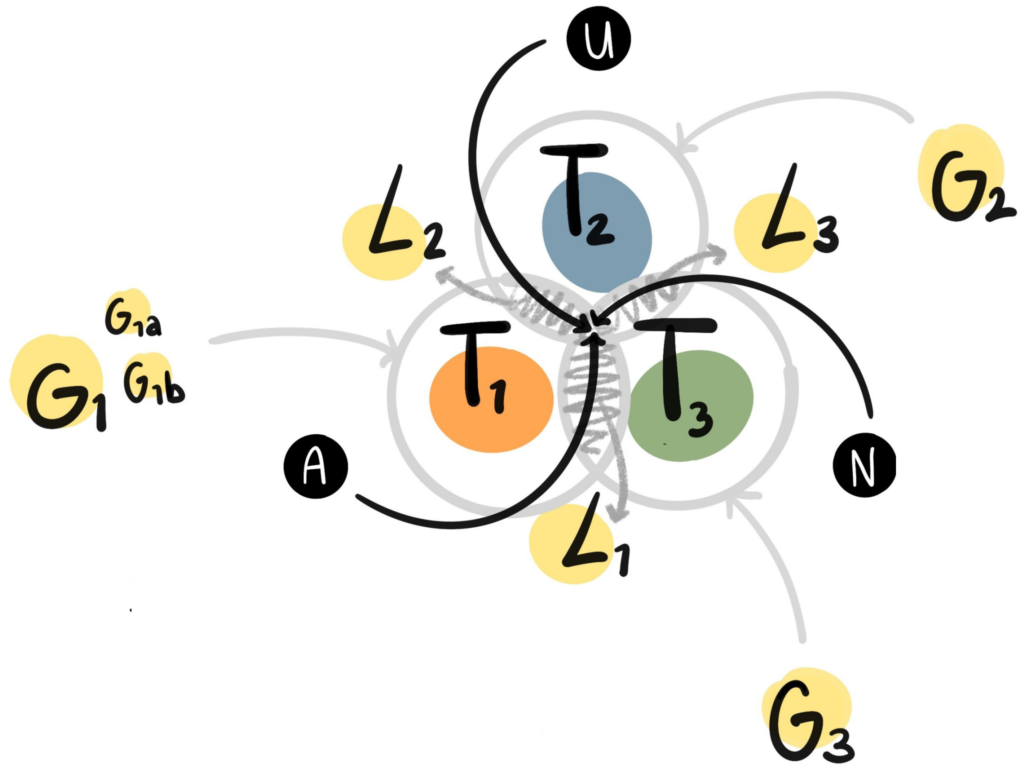
2 Holistic Vision

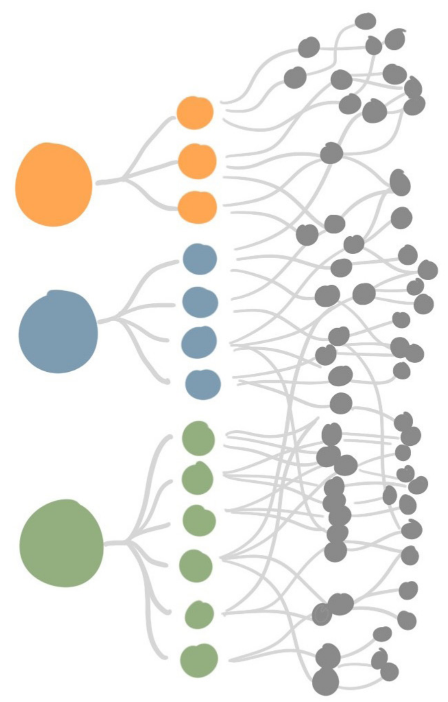
3 Pattern Language

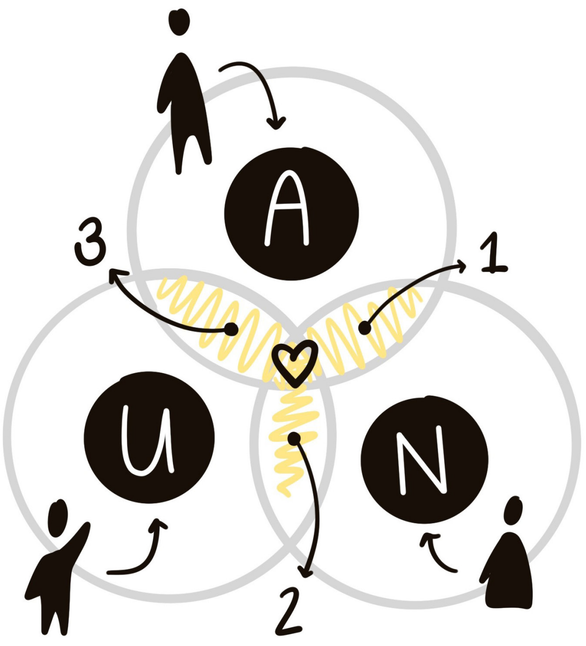
4 Scenario Building

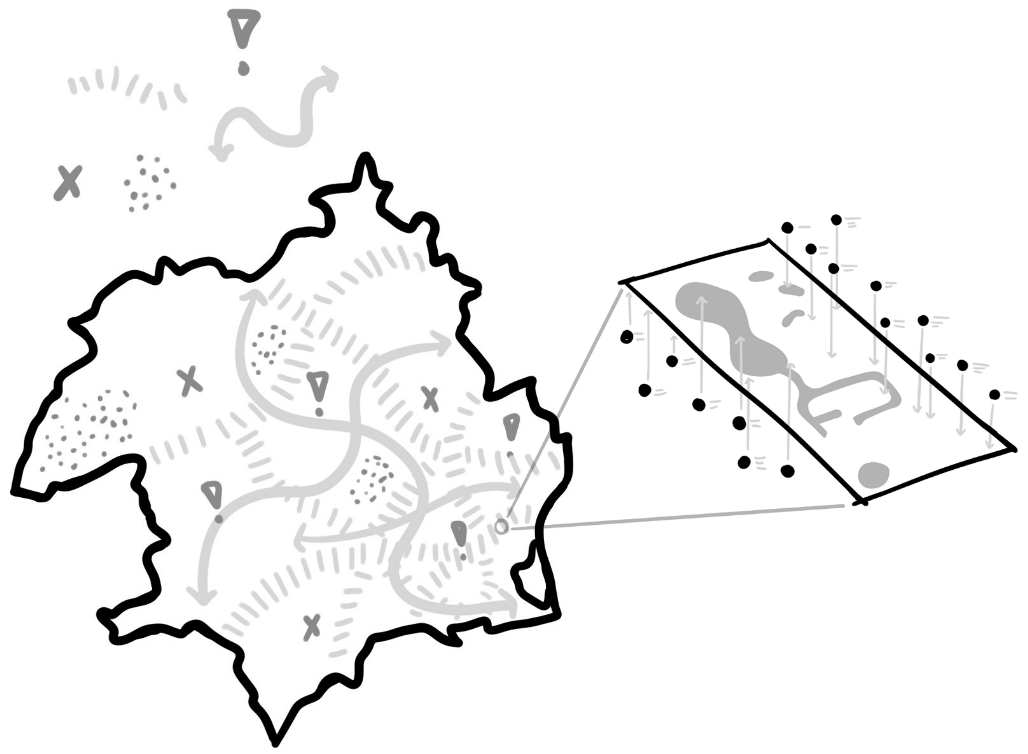
5 Strategic Design





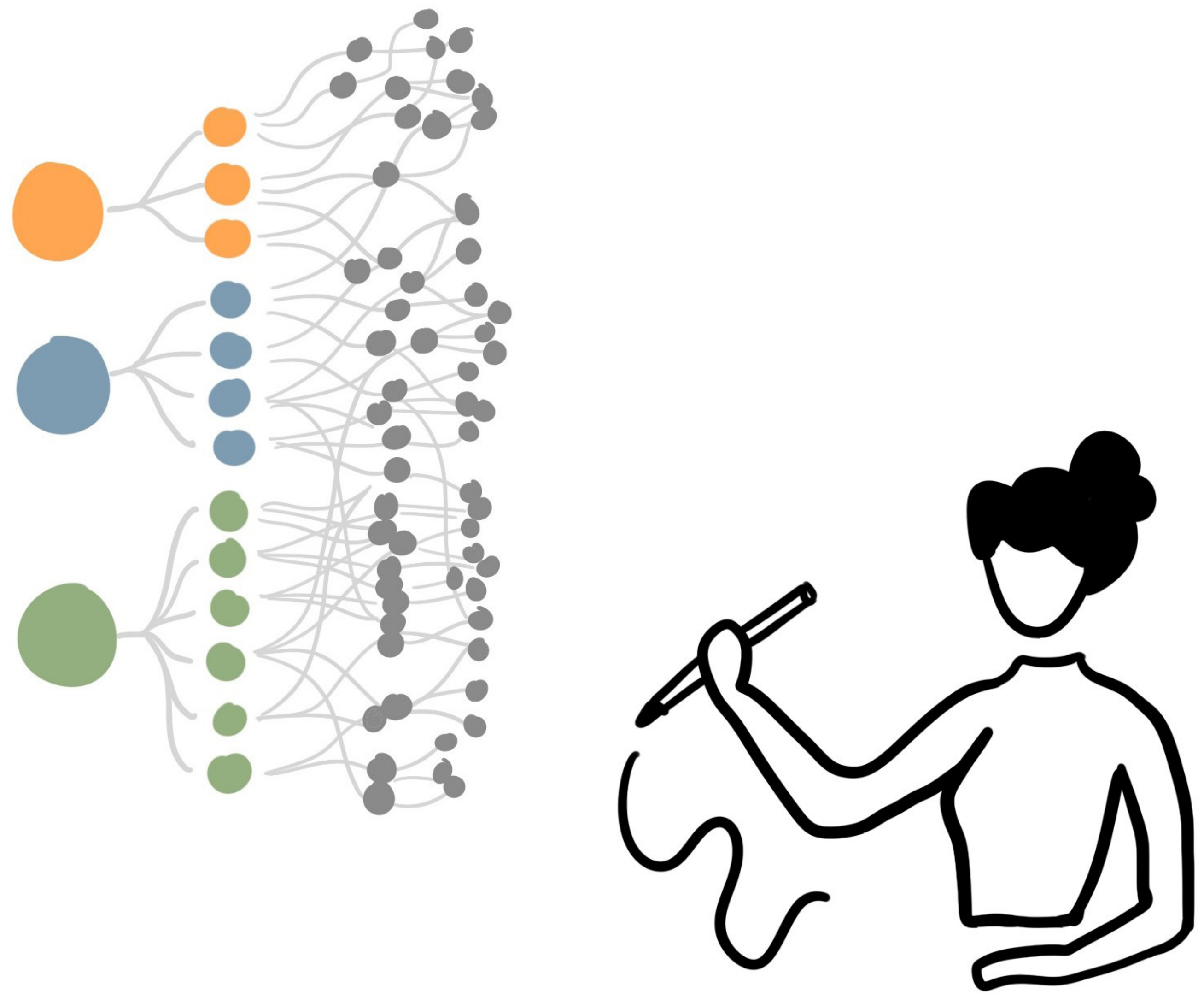




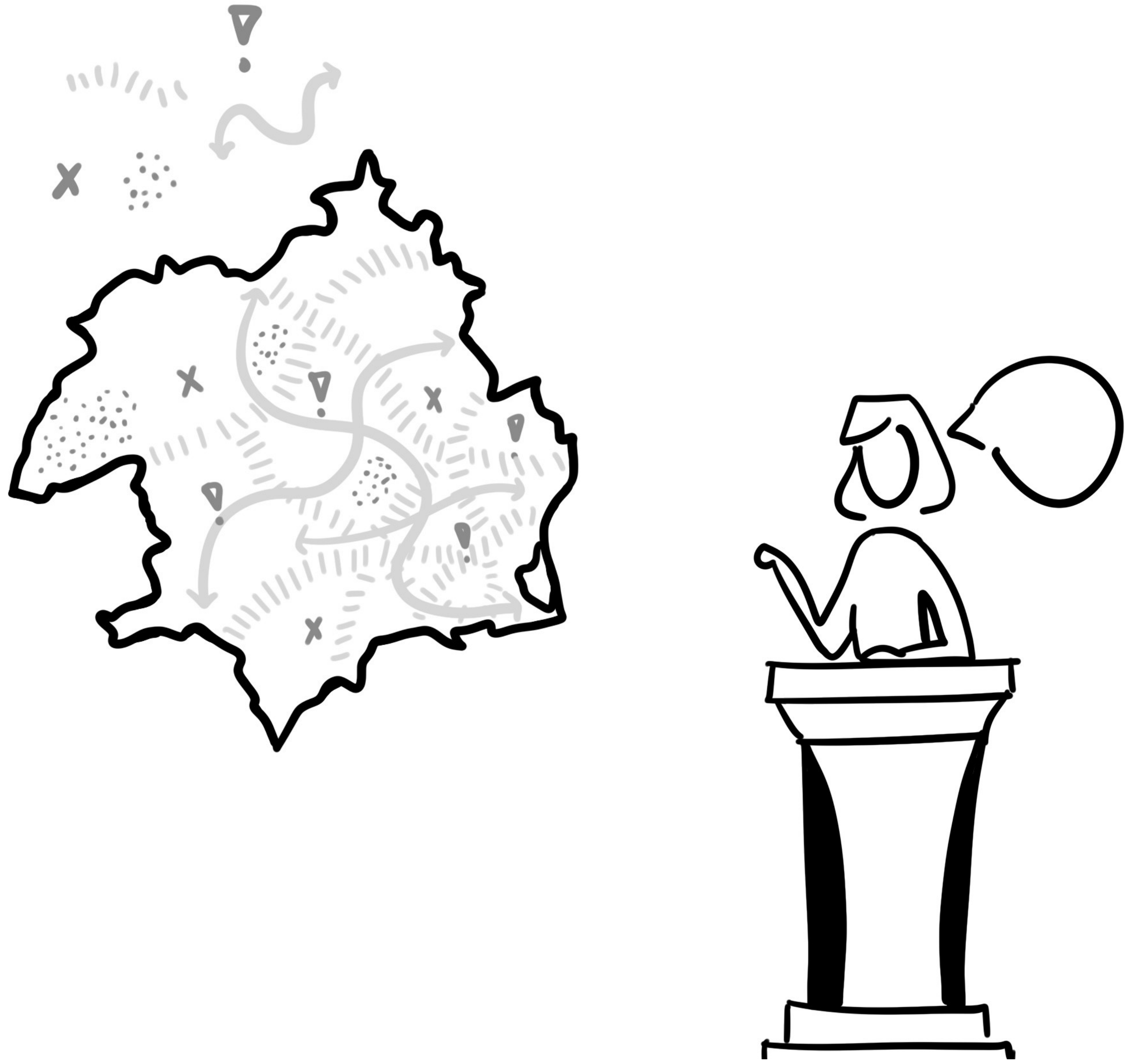


A SYMBIOTIC PATHWAY DESIGN STRATEGY FOR THE WATER SYSTEM TRANSITION TO COMBAT WATER SCARCITY AND DESERTIFICATION IN THE SEGURA RIVER BASIN, SPAIN.

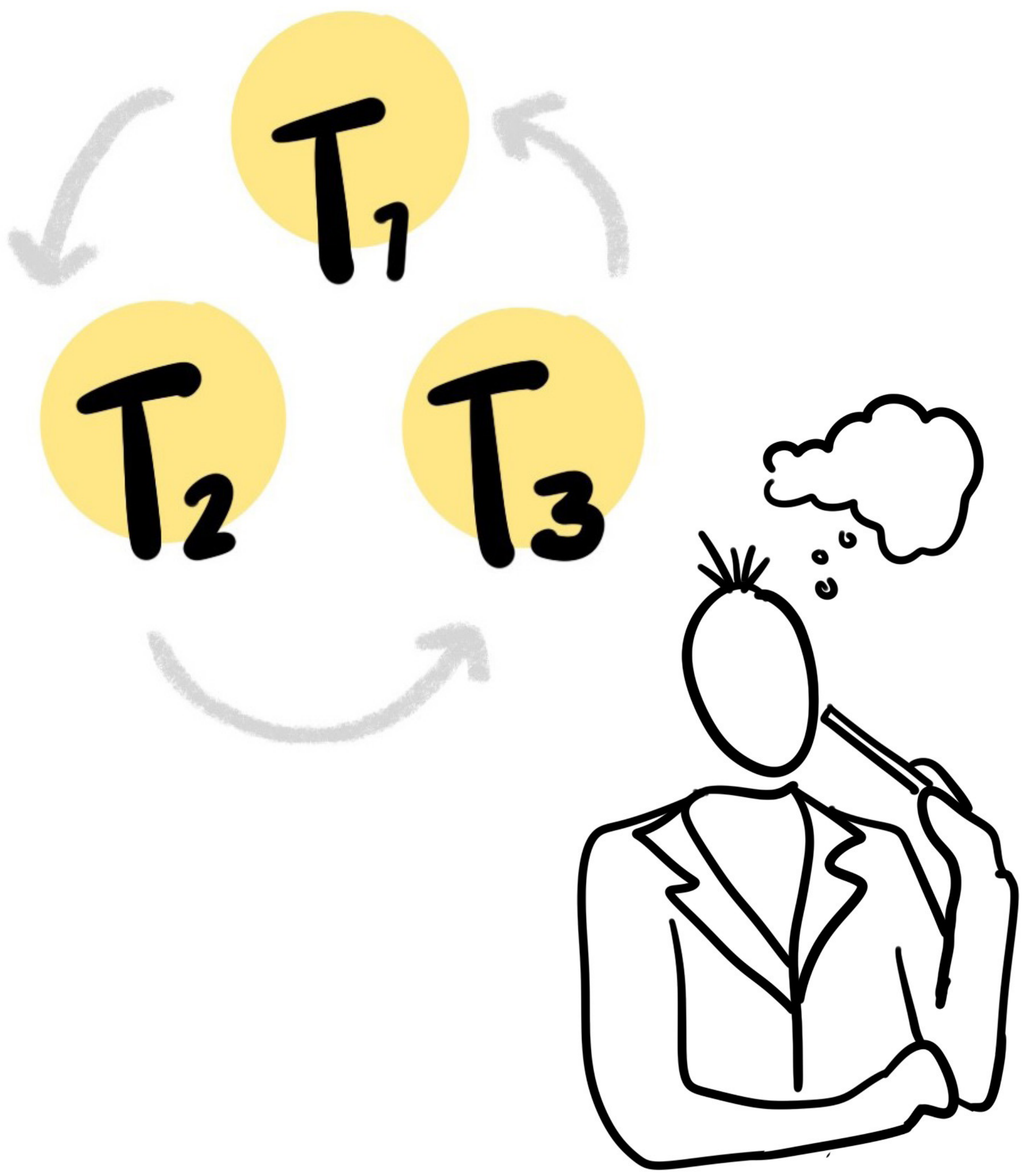
1 A SYMBIOTIC PATHWAY PATTERN LANGUAGE



2 A REGIONAL SYMBIOTIC DESIGN STRATEGY



3 SYMBIOTIC SYSTEMIC DESIGN METHODOLOGY

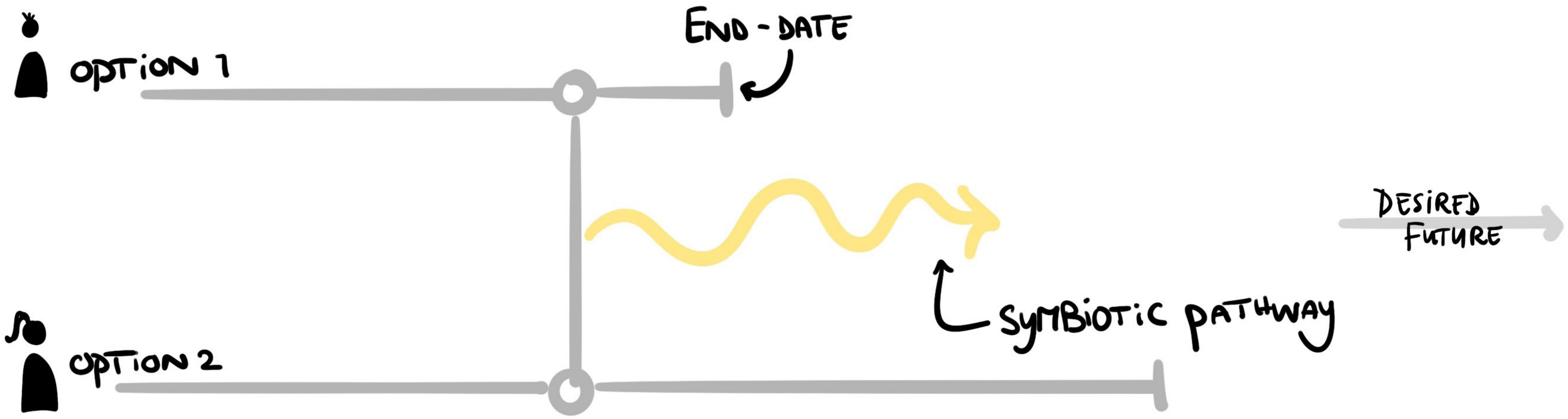


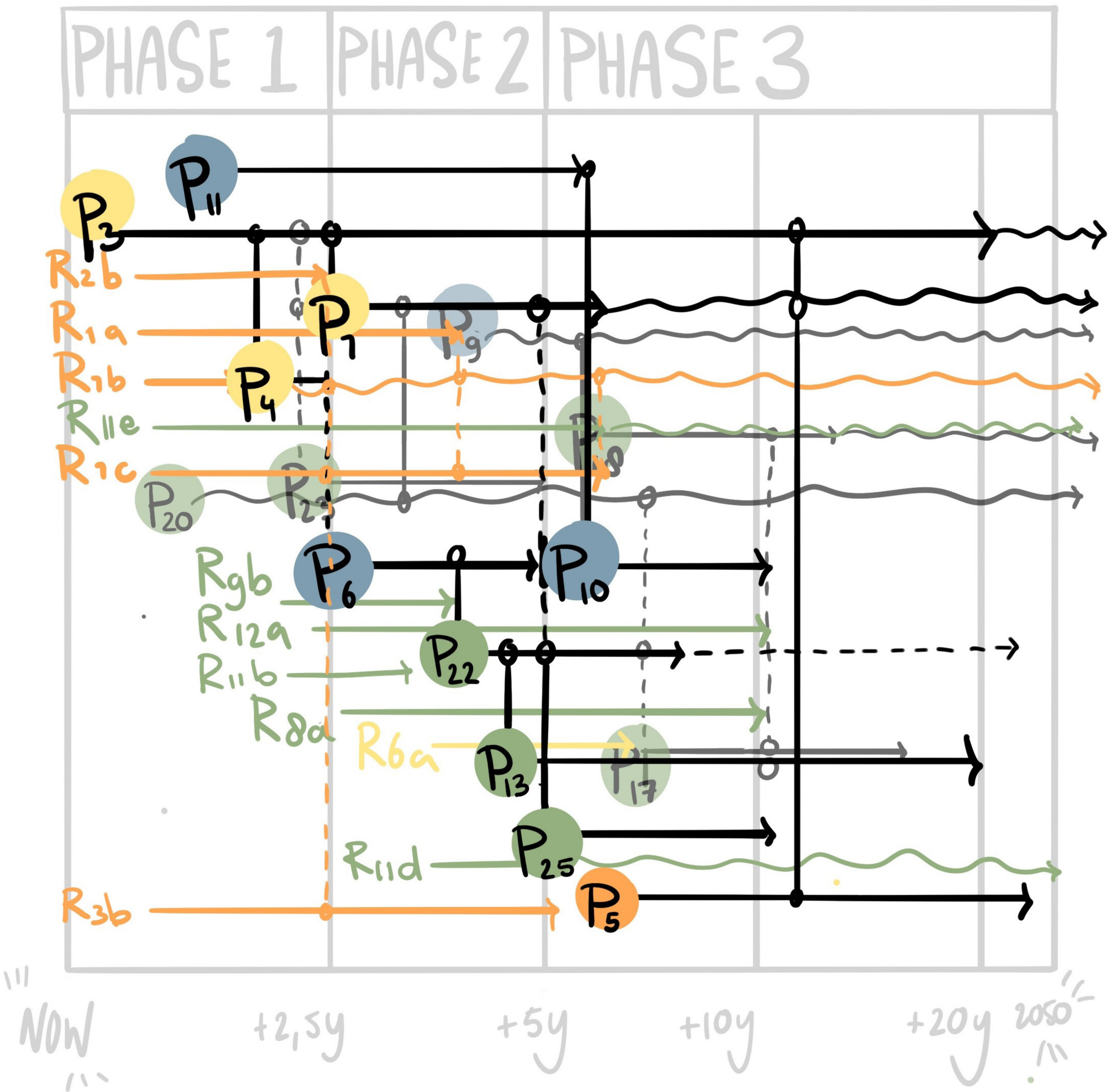
CONCLUSION

DESIGNING FOR SYMBIOSIS WITHIN A COMPLEX SYSTEMIC TRANSITION WITH MANY UNCERTAINTIES AND DIFFERENT OPINIONS IS POSSIBLE, AND NECESSARY, IN ORDER TO CHANGE TOWARDS A SOCIO-ECOLOGICALLY RESILIENT AND WATER-SECURE FUTURE.

THANK YOU!

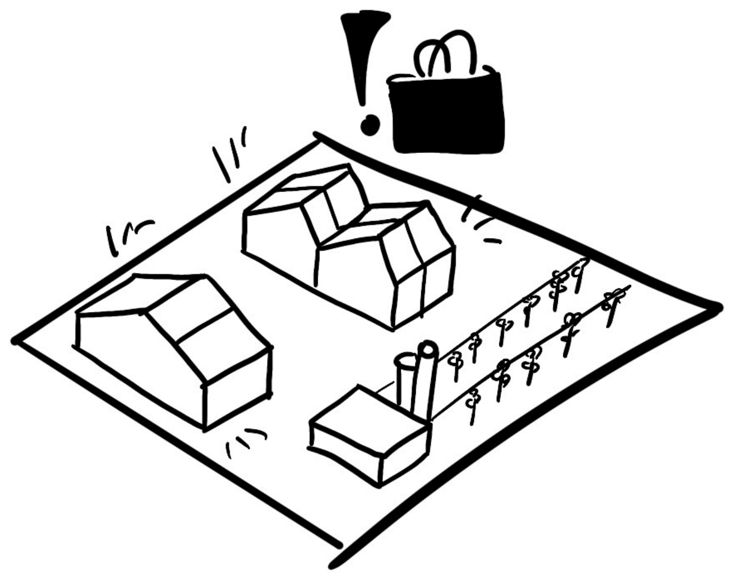
SYMBIOTIC PATHWAYS



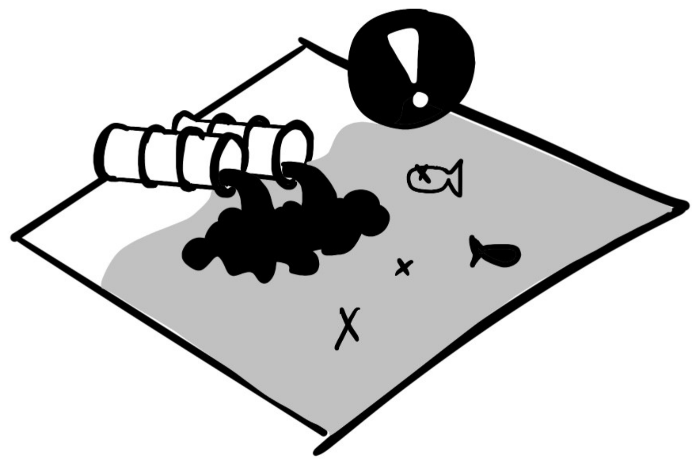


PHASE 1

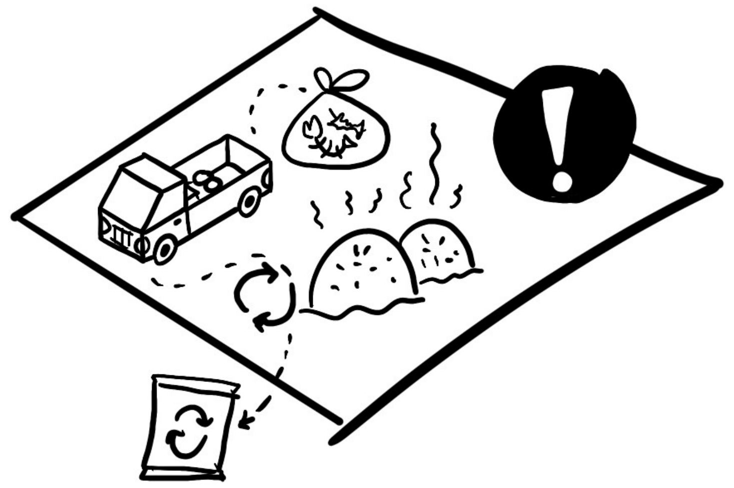
P_3 FOOD POLICY COUNCILS



P_{11} REGIONAL WASTE WATER TREATMENT



P_4 CROSS-SECTORAL ORGANIC WASTE SYSTEM



P_1 TRANSITION TO ORGANIC AGRICULTURE

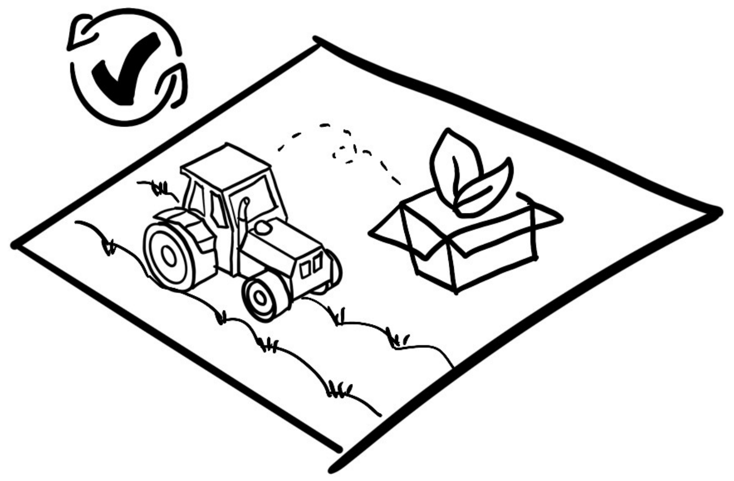
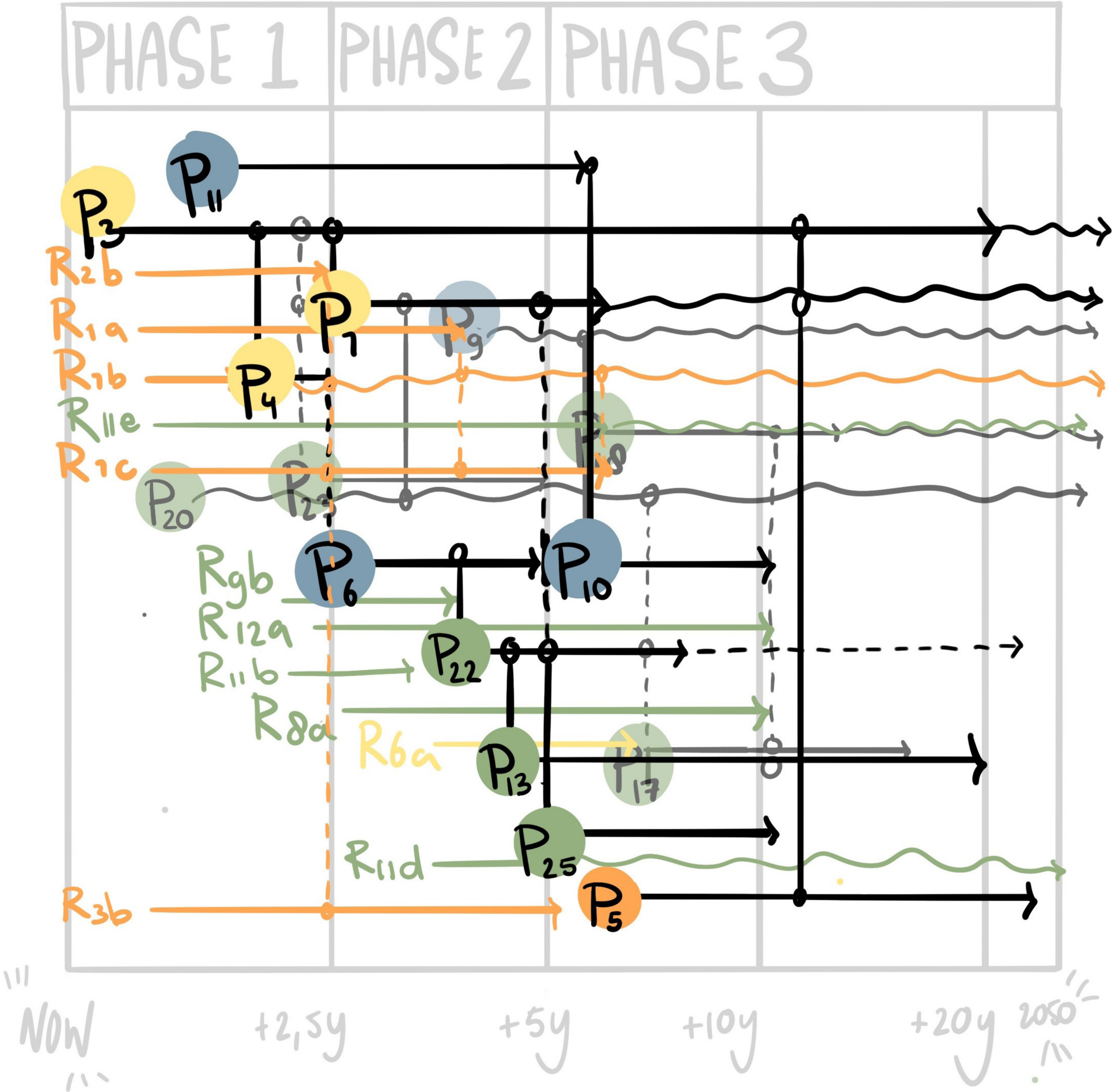
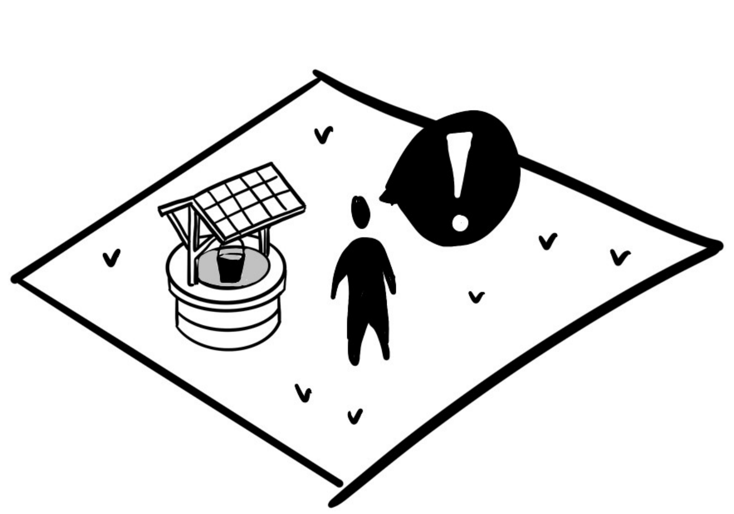


Figure 79. Phasing of interventions of the symbiotic pathway for strategic project 1. Source: made by author.

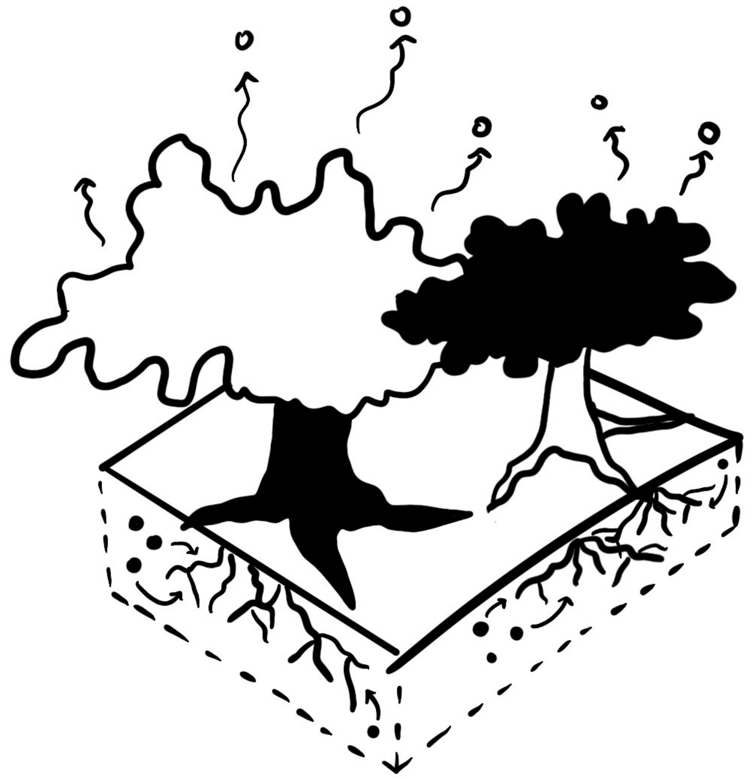


PHASE 2

P_6 ADAPTIVE WATER MANAGEMENT & PRICING



P_{22} SOIL & WATER DECONTAMINATION



P_{13} SOIL TREATMENT

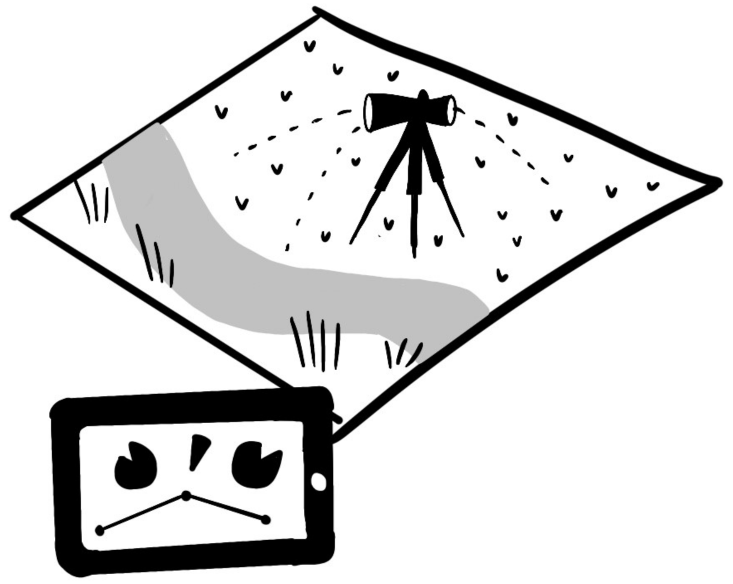
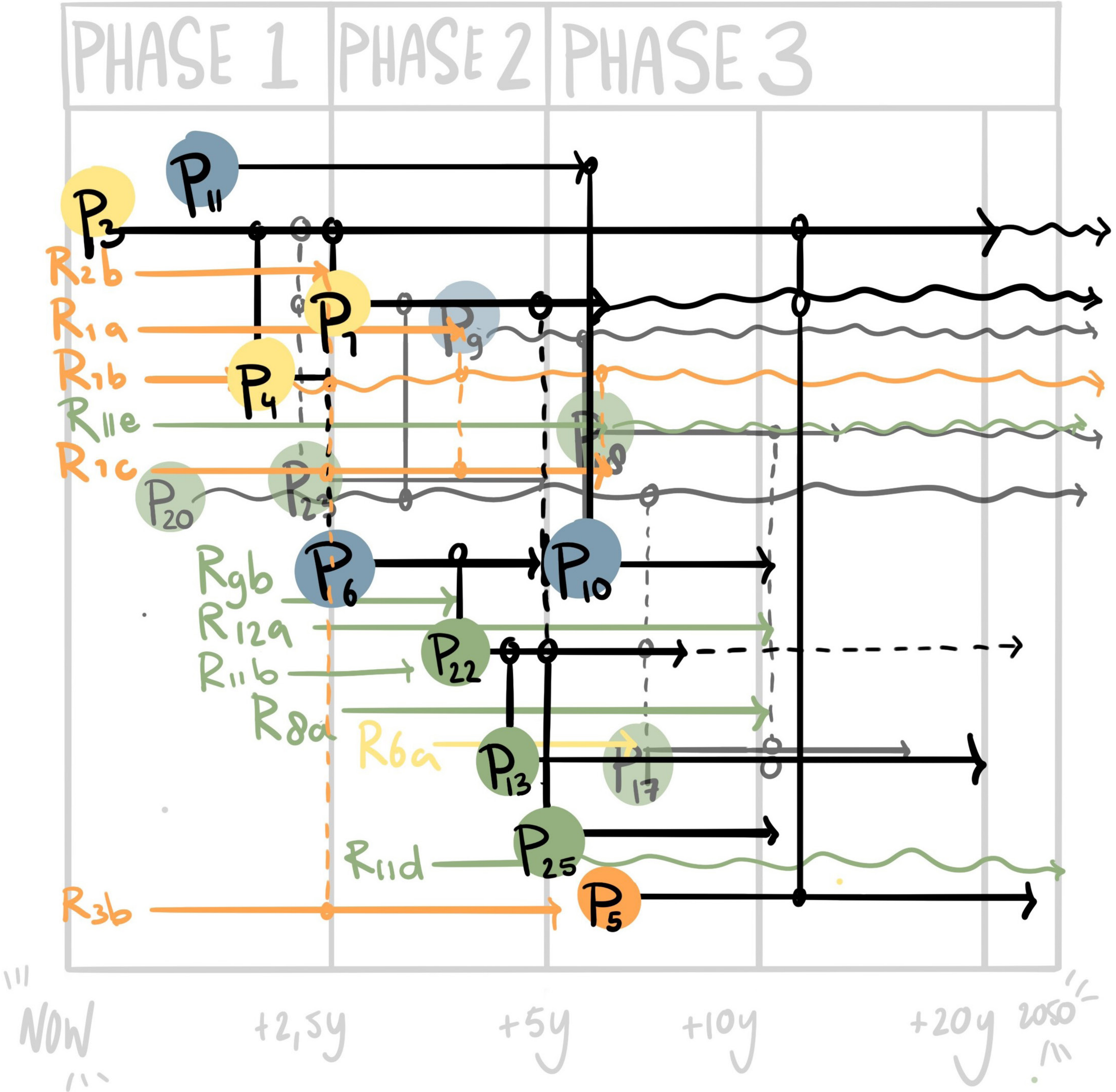


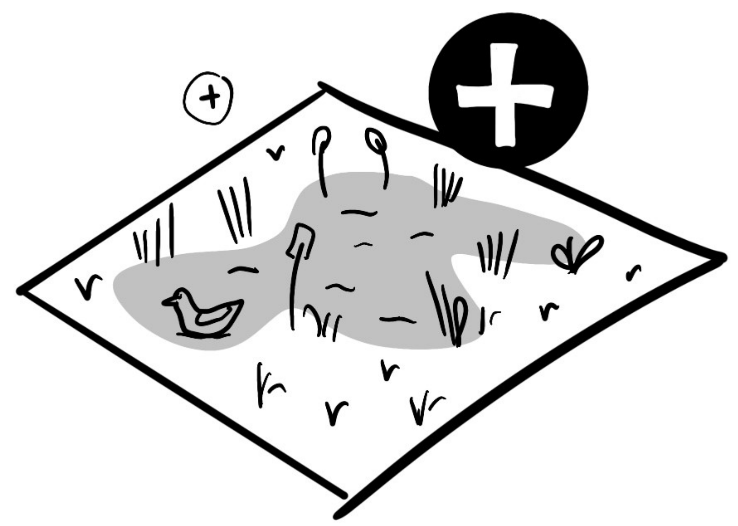
Figure 80. Phasing of interventions of the symbiotic pathway for strategic project 1. Source: made by author.



PHASE 3

P10 CENTRALISED RAINWATER COLLECTION

P25 EXPAND WETLANDS



P5 TECHNOLOGICAL GREENHOUSE HUB

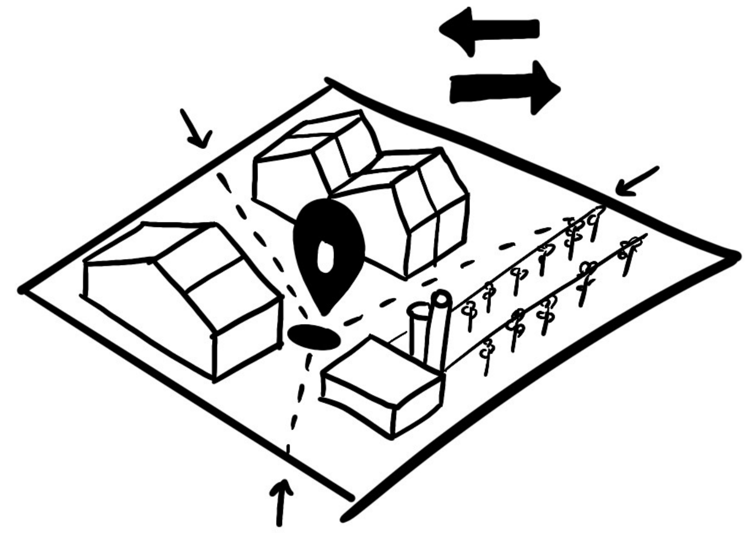


Figure 81. Phasing of interventions of the symbiotic pathway for strategic project 1. Source: made by author.

NO-REGRET MEASURES

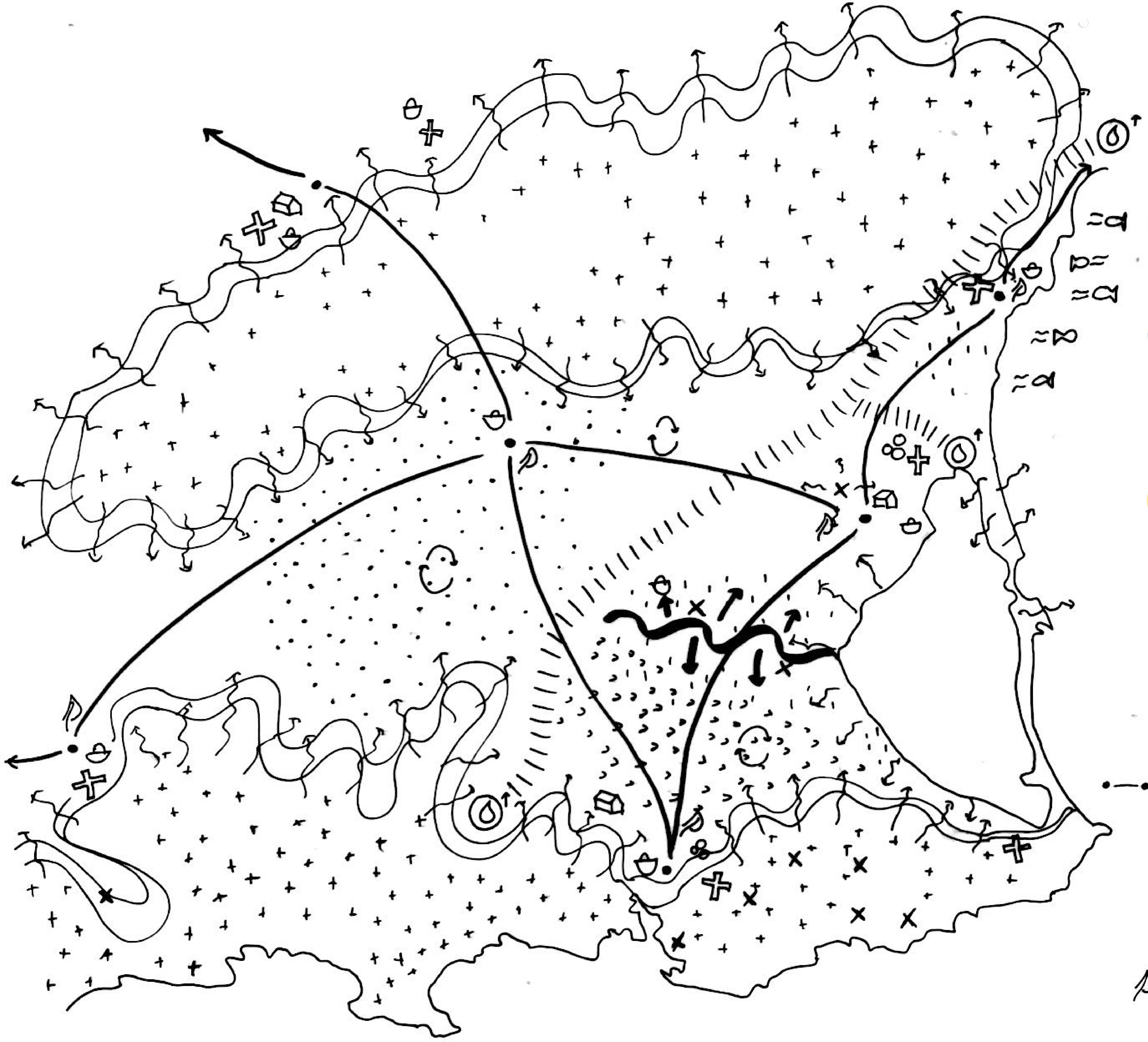


Figure 82. Map of the no-regret measures when comparing all scenarios spatially. Source: made by author.

P8 IMPROVE THE DESALINATION NETWORK
- A24 TRANSFORM TST INFRASTRUCTURE
- A26 EXPAND DESALINATION PLANTS

P10 CENTRALISED RAINWATER COLLECTION NETWORK

P11 WASTEWATER TREATMENT NETWORK
- A35 WASTEWATER TREATMENT PLANTS
- A36 ALGAE MATERIAL HUB

P1 TRANSFORM TO ORGANIC AGRICULTURE
- A1 DROUGHT TOLERANT CROPS
- A2 TERRACING
- A3 TRANSITION PARCALS TO NATURE
- A4 SALT TOLERANT CROPS
- A5 SEAWEED FARMING
- A6 VEGETATED PARCEL DIVISIONS
- A8 ORGANIC MULCHING
- A9 CROP ROTATION
- A10 NATURAL PEST CONTROL
- A13 SILVOPASTURES
- A18 AI FARMING

P2 LOCAL FOOD PROCESSING & DISTRIBUTION HUBS
- A19 FARMER MARKETS
- A20 URBAN FARMING

P3 FOOD POLICY COUNCILS
- A37 AGRICULTURE RETURN FLOWS
- A16 KNOWLEDGE PLATFORM

P4 CENTRALISED ORGANIC WASTE COLLECTION

P13 SOIL TREATMENT
- A2 TERRACING

P16 WATER EXTRACTION ACCORDING TO WEATHER

P17 REFORESTATION

P20 BIODIVERSTIY PROJECTS
- A47 PONDS
- A49 URBAN GREEN STRIPS

P22 SOIL & WATER DECONTAMINATION
- A55 PHYTOEXTRACTION
- A56 PHYTOSTABILISATION

P23 RIPARIAN BUFFERZONES

P26 EXPAND RAMBLAS

P27 WATER RETENTION AREAS
- A58 RAIN COLLECTION ROOFS
- A59 WADIS
- A60 PERMEABLE PAVEMENT
- A61 URBAN VEGETATED FLOODQUAYS

P28 ECOTOURISM
- A63 ELEVATED PATHS
- A64 AMPHIBIOUS PARKS
- A65 INFORMATIVE ROUTE

FULL STRATEGY

SYMBIOTIC PATHWAY PROJECTS

- P_5 = greenhouse hub
- P_{22} = clean corridors
- P_{13} = detached systems

SECTOR SYMBIOTIC MEASURES

- P_2 = food processing and distribution hubs
- P_{11} = wastewater treatment plants
- P_8 = upgrade desalination infrastructure

NO-REGRET MEASURES

- P_{17} = reforestation
- P_{10} = rainwater collection and return flows
- P_{18} = ecological corridors, expansion protected nature

Figure 83. A visual impression of the strategy for a symbiotic system transition on the scale of the sub-basin. Source: made by author.

... TO BE CONTINUED ...

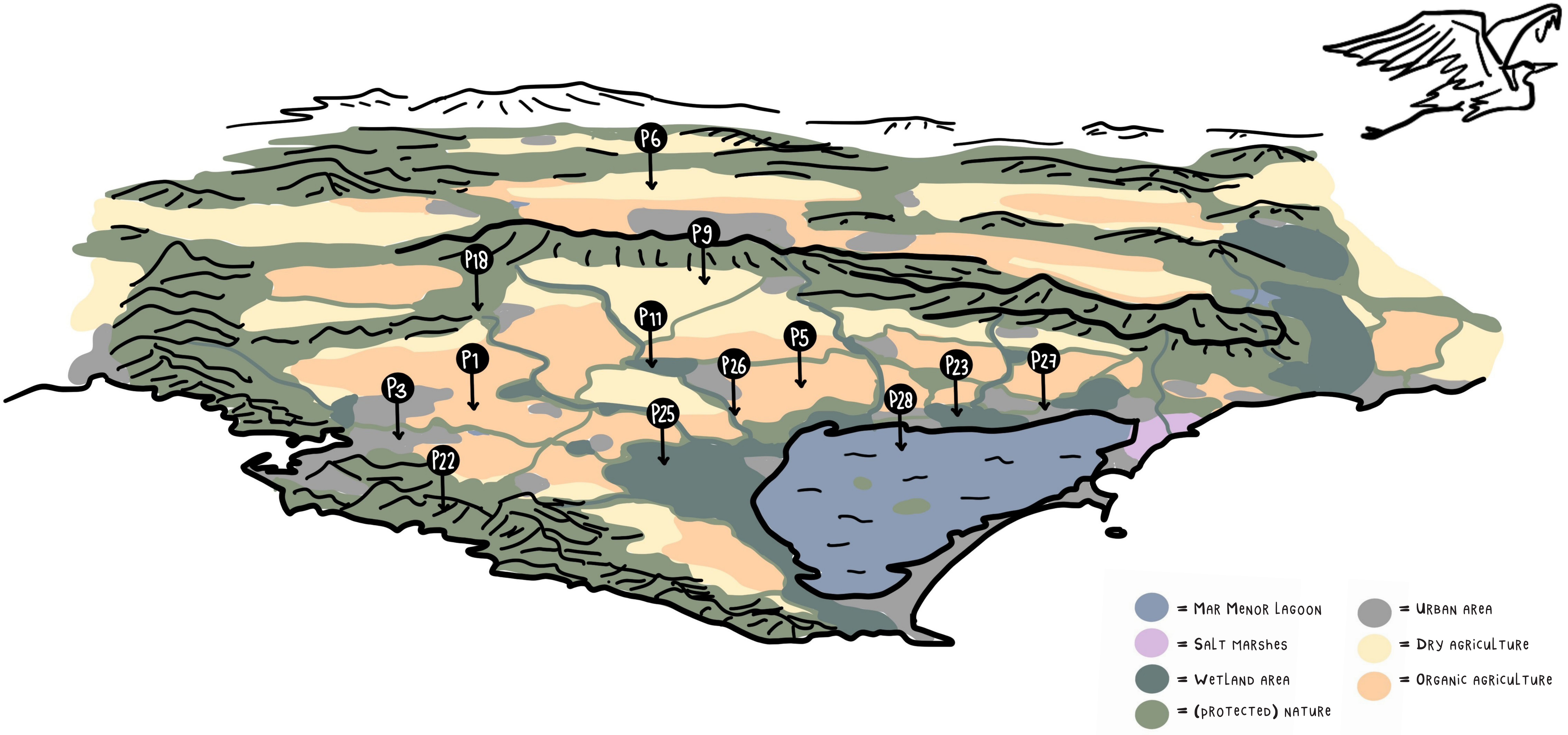


Figure 84. A visual impression of the strategy for a symbiotic system transition on the full basin scale. Source: made by author.

NETWORK APPROACH – 3 LAYERS

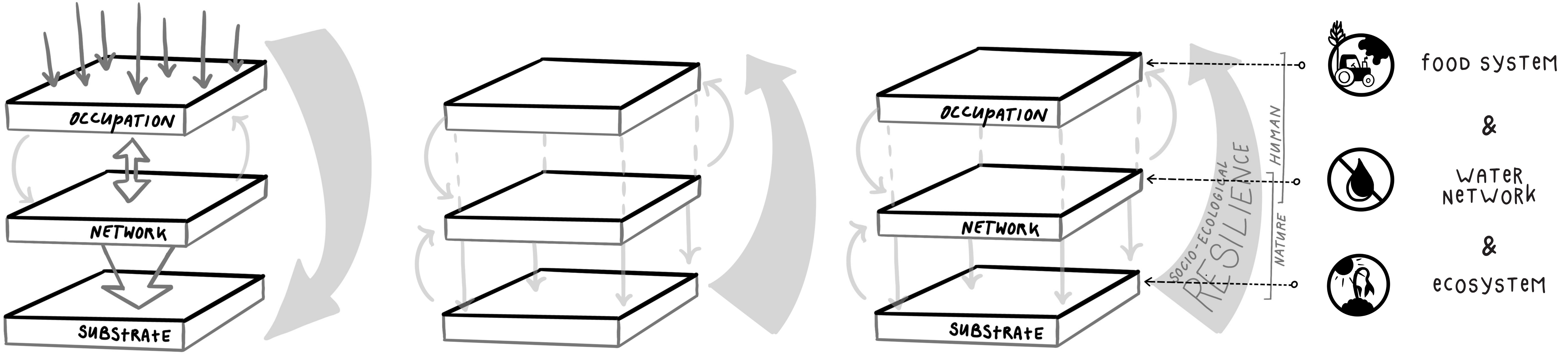


Figure 85. Left: the Dutch Layers Approach, Middle: the Network Approach. Source: made by author, based on (de Hoog et al., 1998 & Priemus, 2004 & 2007).

Figure 86. Right: the Network Approach applied to this research. Source: made by author.

Next to big industrialised monocultural farms, also small farms exist in the area. An old man was spotted on his bycile, cycling through his fields, with a dog on a leash and a basket of fresh broccoli on the back of the bike.

Due to a few days of heavy reainfall in the area, the lowlands were in full bloom, showing almost no signs of struggles with drought and desertification.

In between the sea and the lagoon, a small strip of 600 m wide is fully built with appartment buildings of tourism appartments that were almost all vacant and for sale. A highway of cars divided the connection between the waters.

From up close, the drip irrigation systems did not seem sustainable at all, as they are made out of small plastic tubes that create piles of plastic waste when big ploughs rush through the landscape.

The harbour of Cartagena is where the food export industry of the region is most visible: big containerships line up and landscapes of refineries and cranes define the coastline.

Abandoned water mill and aquduct, connected to an abandoned farm. It shows the heritage of the region, but was left neglected within the protected wetland area.

In the inland, the car roads divided natural landscapes and areas of agricultural production that formed a sea of plastic or bare deserts of abandoned land.

In a tourist village near the lagoon, an eco-tourism route was created, providing information about the historic and ecological relevance of the salt marshes.

Figure 87. Sketches of the field visit observations. Source: made by author.

Figure 88. Image of the urban tourism strip between the lake and the sea. Source: Made by author.

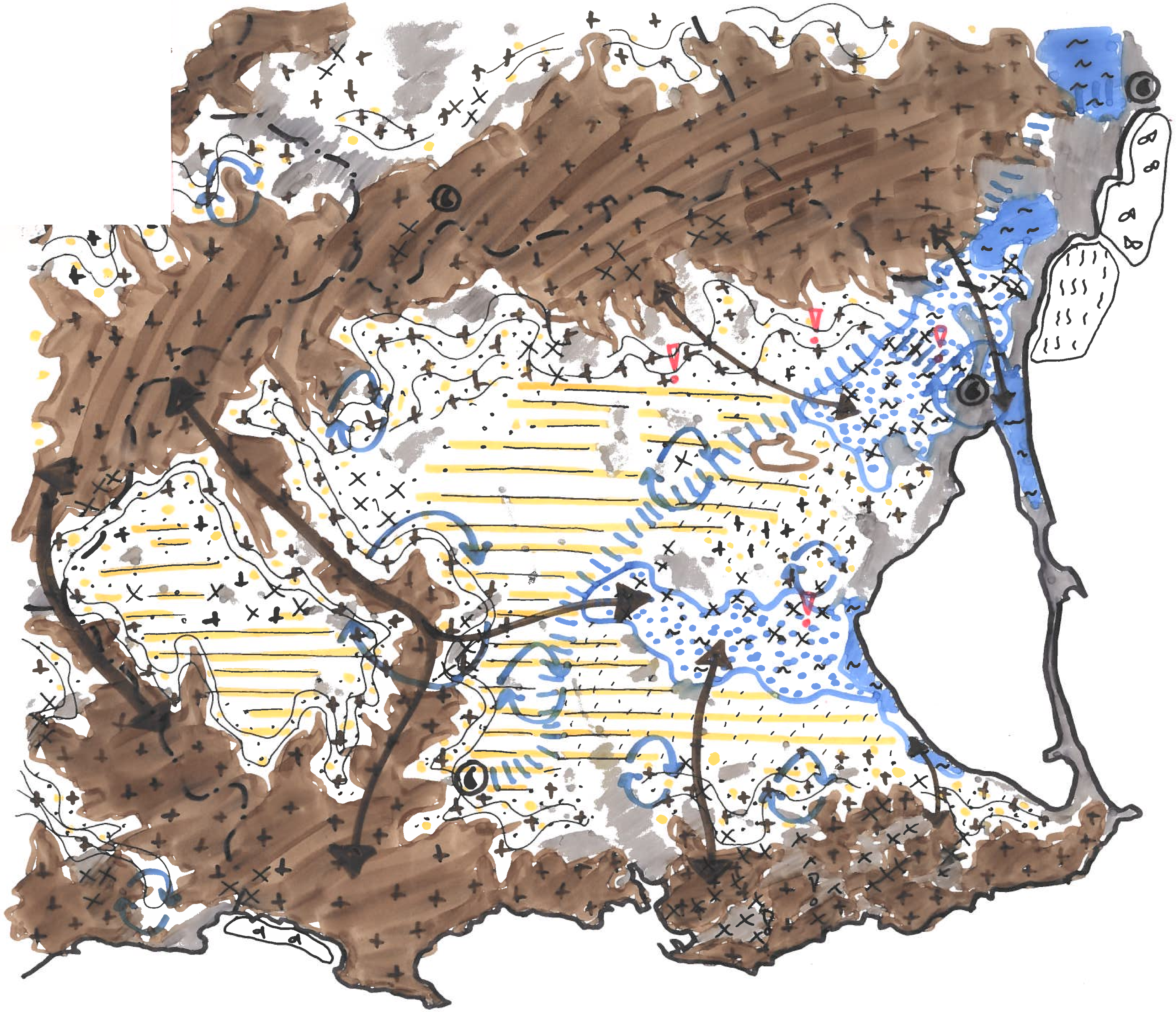


Figure 89. Map of the patterns applied in the sub-basin according to scenario 1. Source: made by author.

ORGANIC PRODUCE
SCENARIO 1

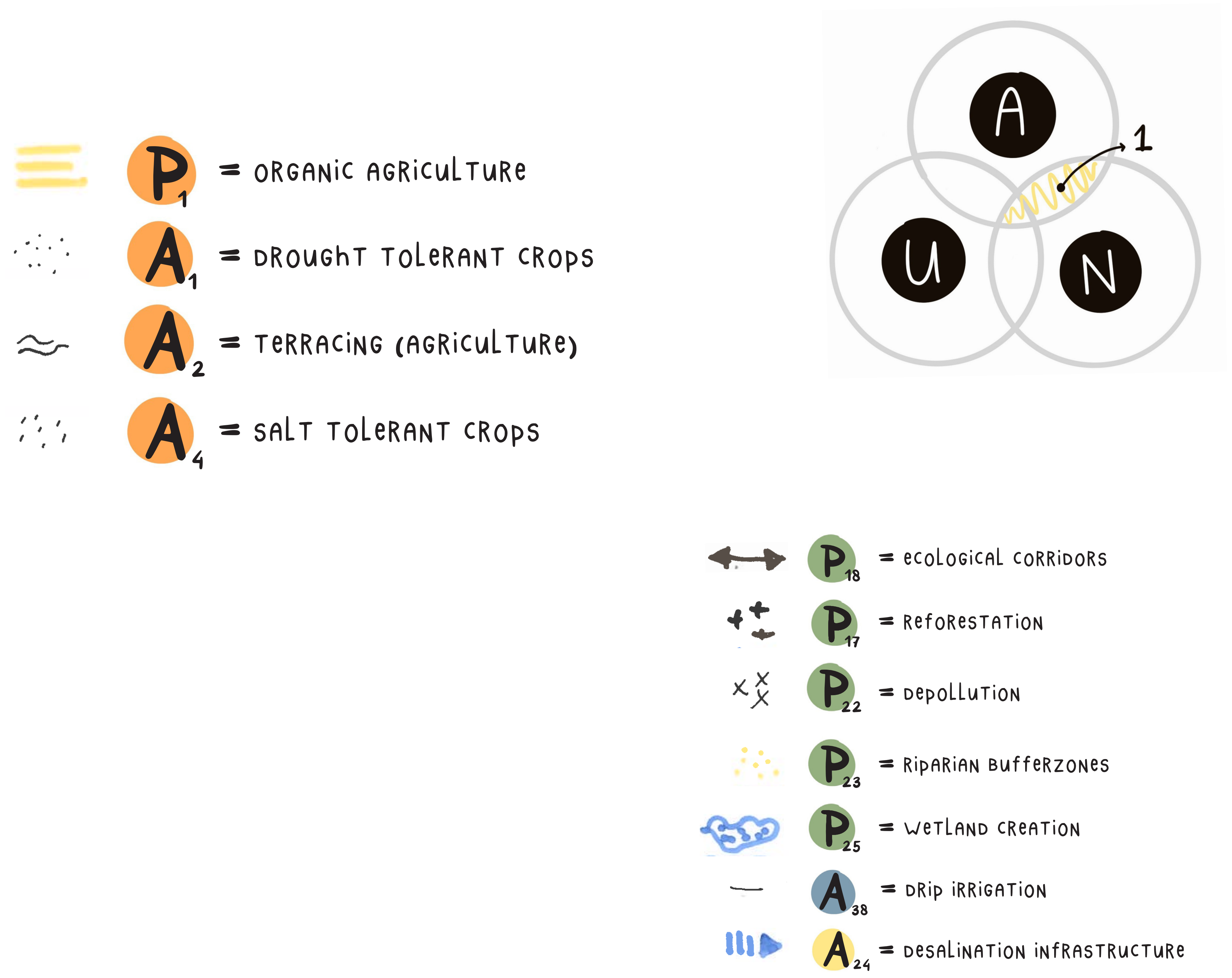
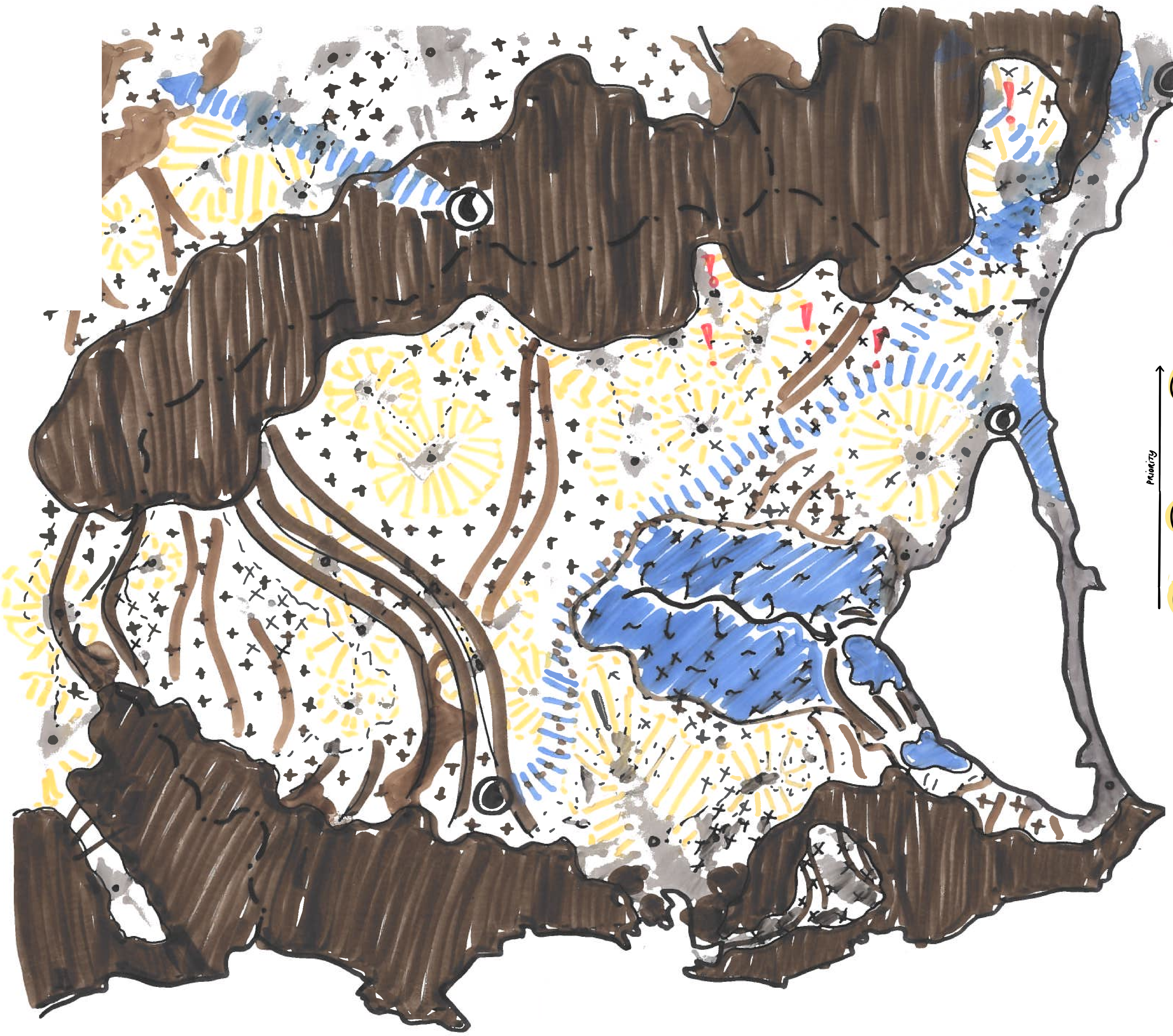


Figure 90. Selection of scenario based patterns for scenario 1. Source: made by author.

SELF-SUFFICIENCY
SCENARIO 2



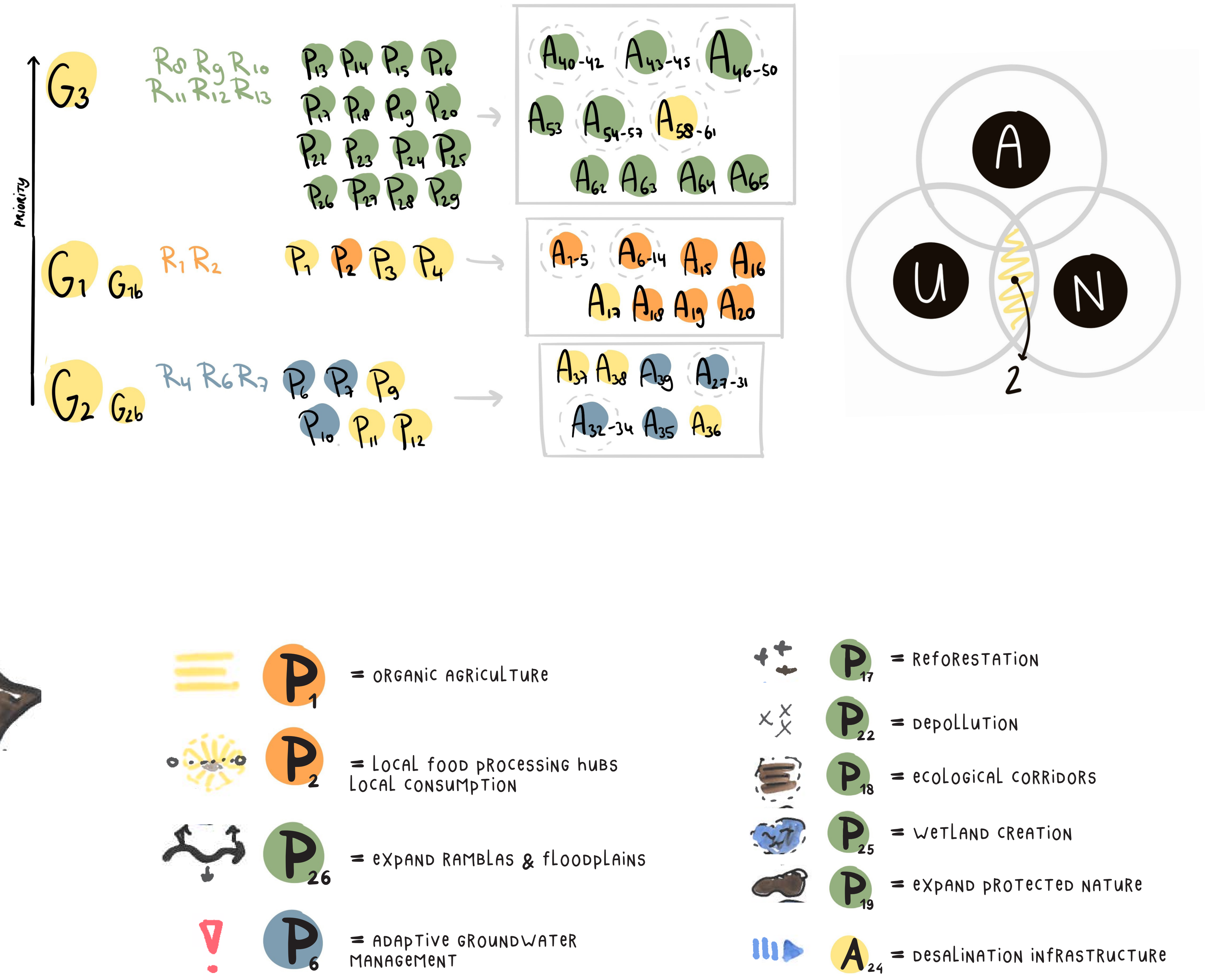


Figure 91. : Map of the patterns applied in the sub-basin according to scenario 2. Source: made by author.

Figure 92. Selection of scenario based patterns for scenario 2. Source: made by author.

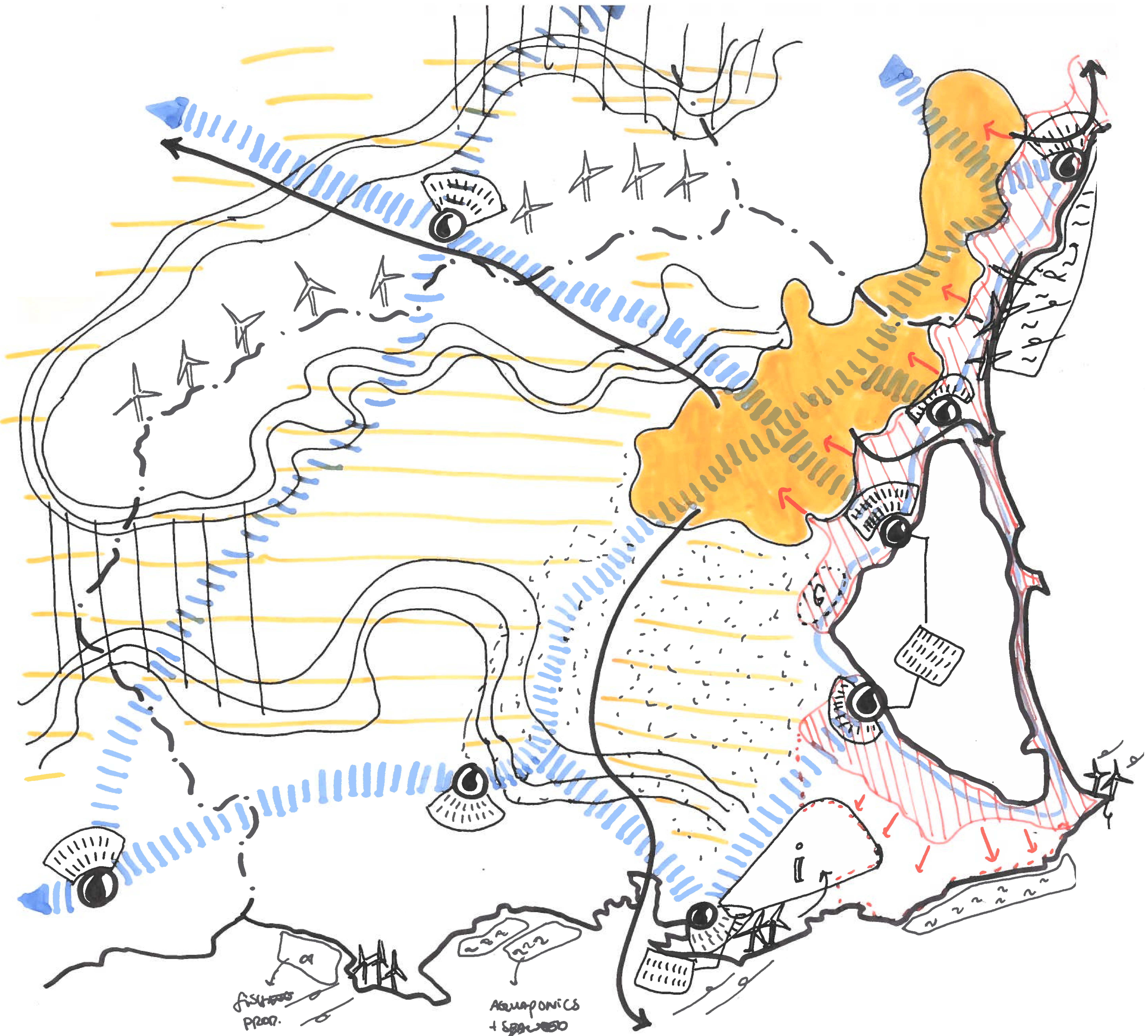


Figure 93. : Map of the patterns applied in the sub-basin according to scenario 3. Source: made by author.

INNOVATIVE PRODUCTION
SCENARIO 3

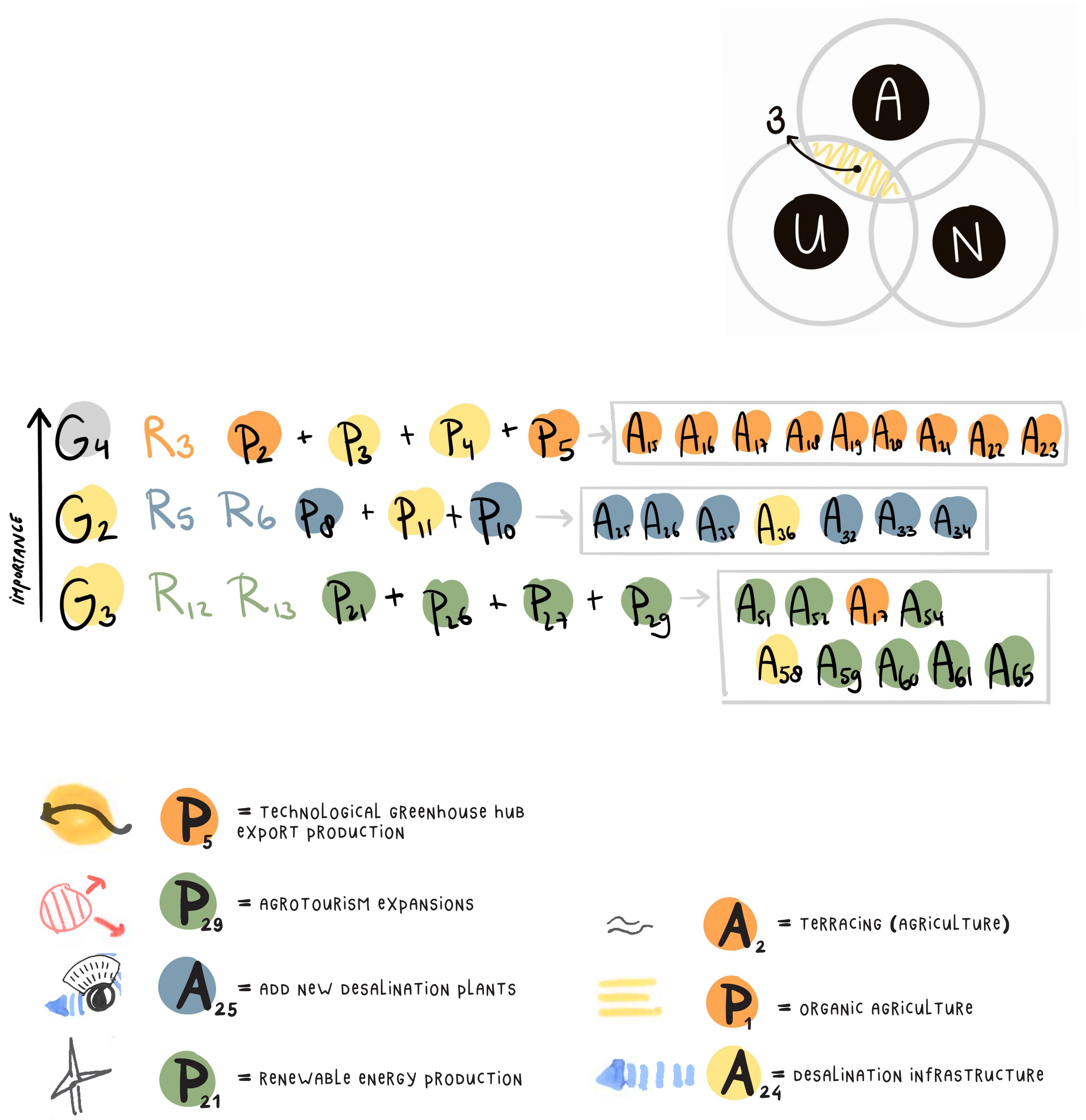


Figure 94. Selection of scenario based patterns for scenario 3. Source: made by author.