

A painting of a river landscape. In the foreground, there are dark, silhouetted trees and foliage on the left and bottom. The river flows from the foreground towards the background. A small sailboat with a reddish-brown sail is on the river. In the distance, a church spire is visible against a hazy, overcast sky. The overall style is impressionistic with soft colors and visible brushstrokes.

Restoring Rivers

Integrating a renaturalised Maas river basin with the cultivated landscape to enhance climate resilience

Esmee de Quant

MSc Thesis Urbanism | TU Delft | P5

16/01/2026



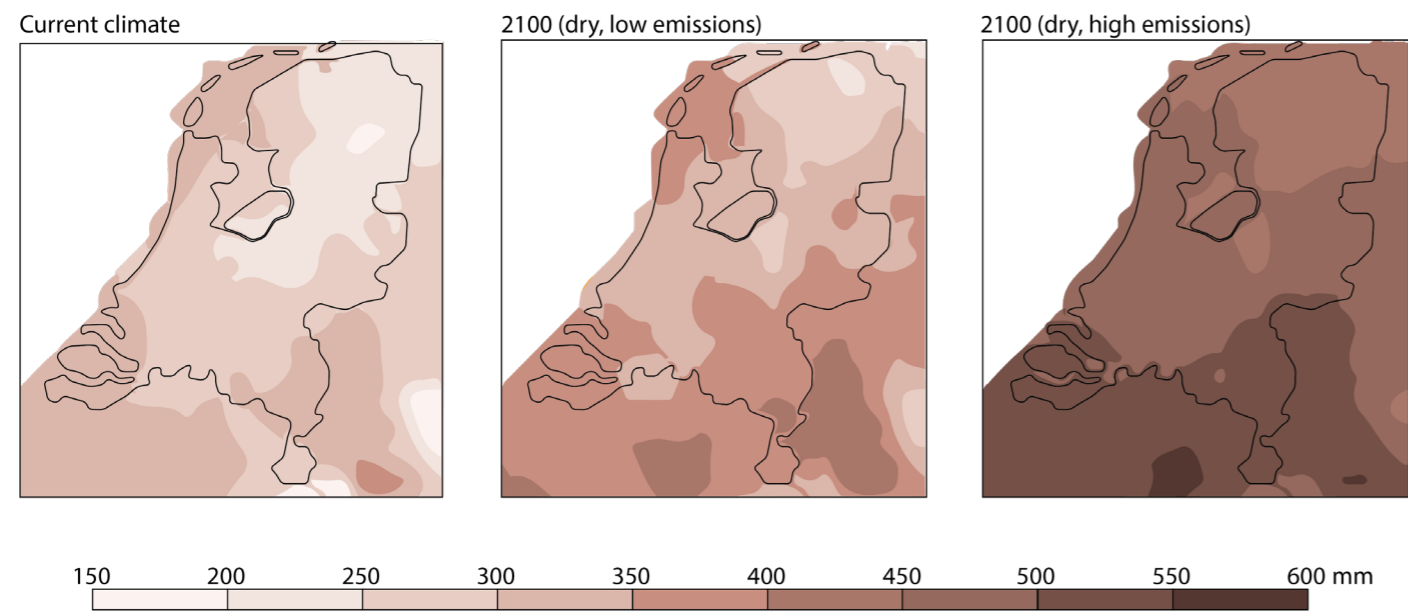
Flooding in Roermond, July 2021
Source: ANP (2021)



Forest fire in the Maasduinen, June 2023
Source: NOS (2023)

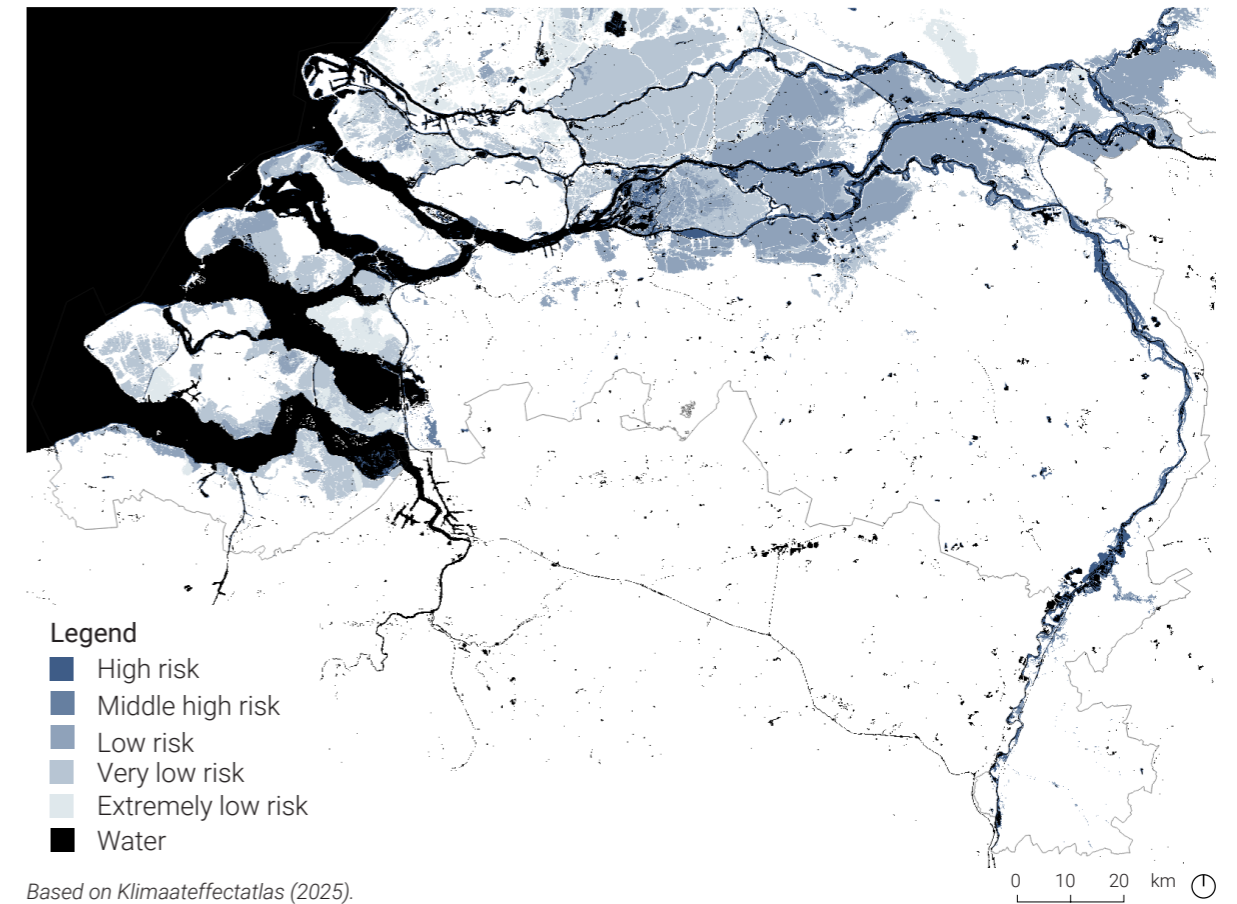
Climate change

Precipitation deficit



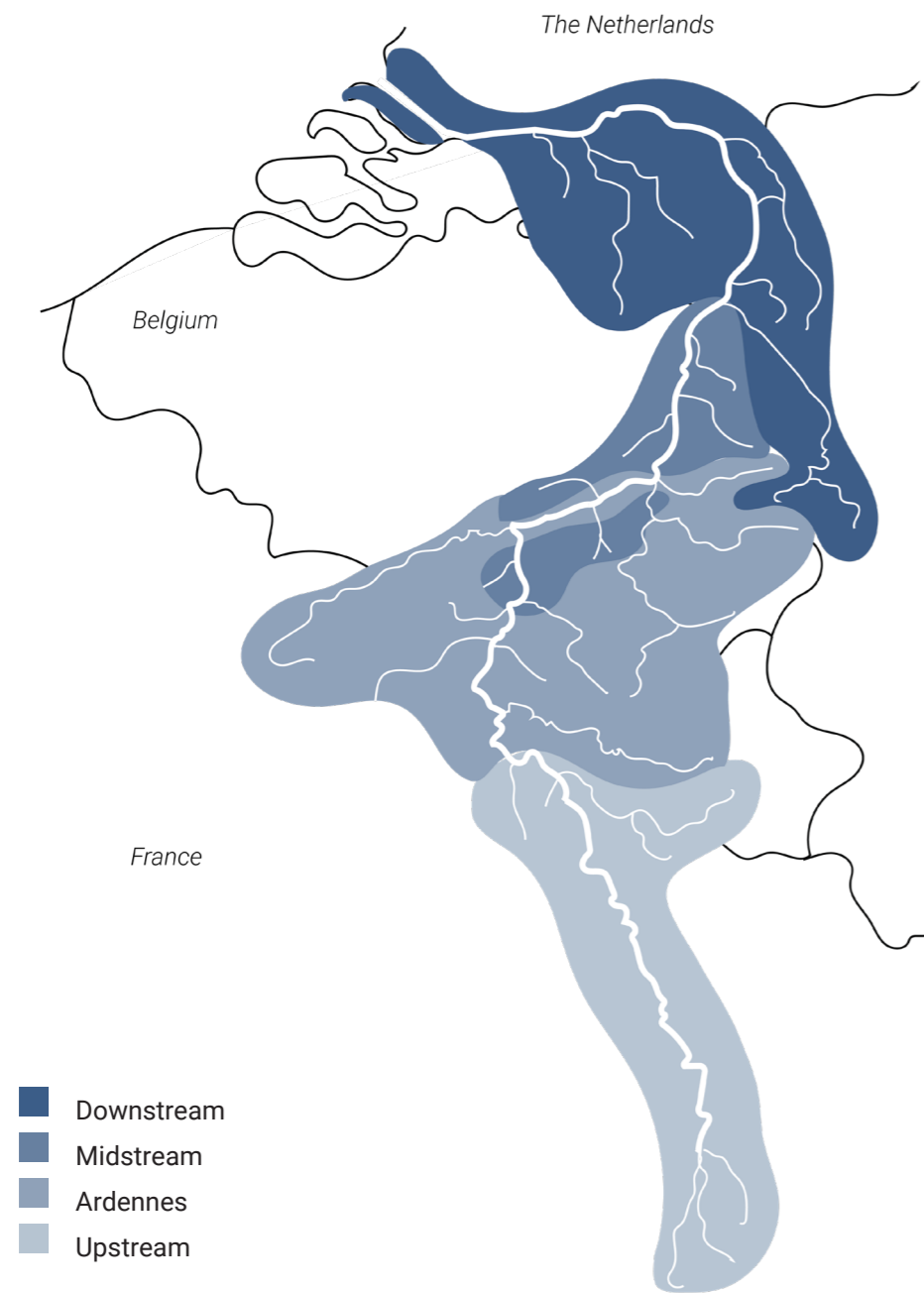
Based on KNMI (2023).

Flood risk in 2100



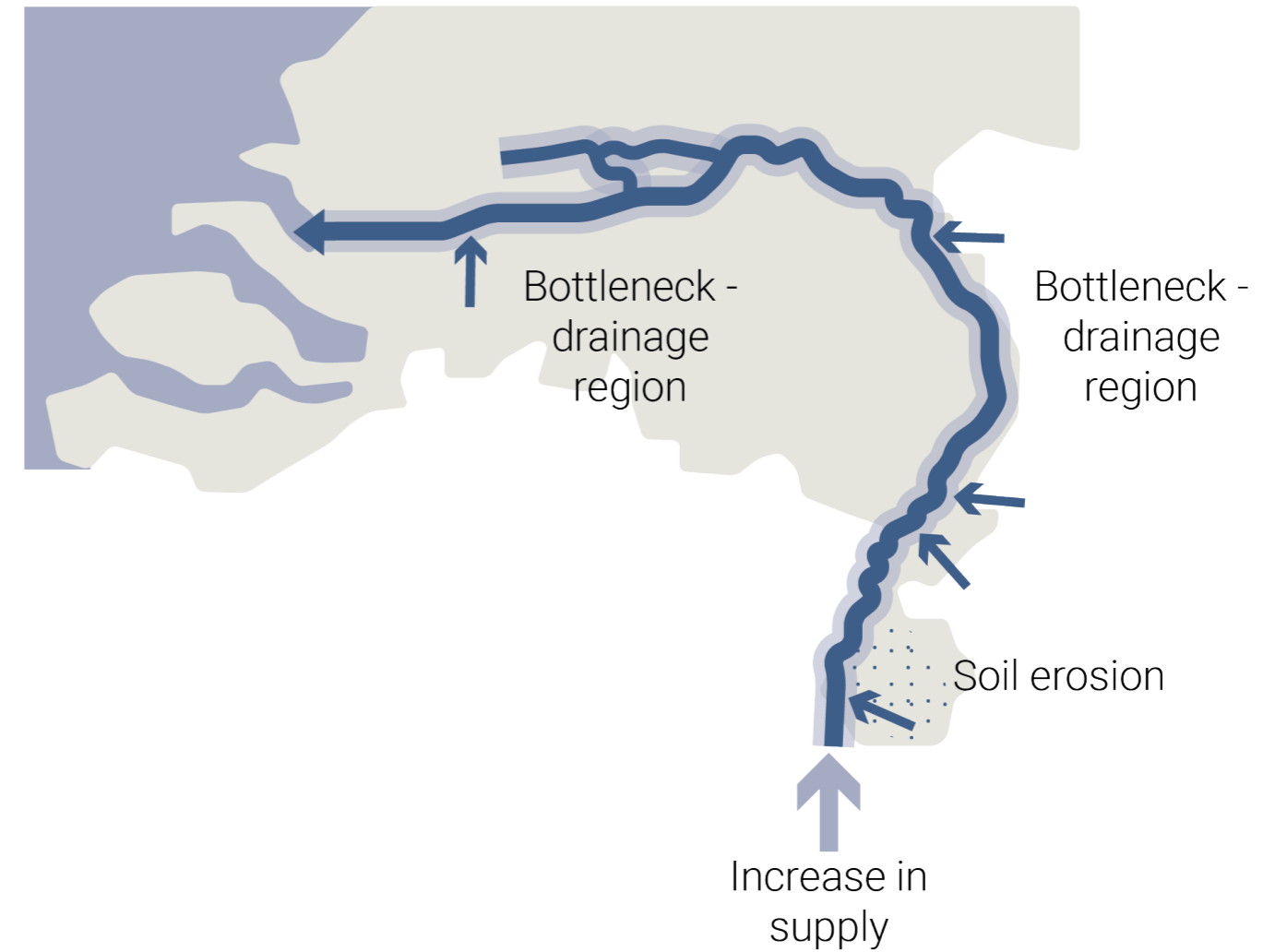
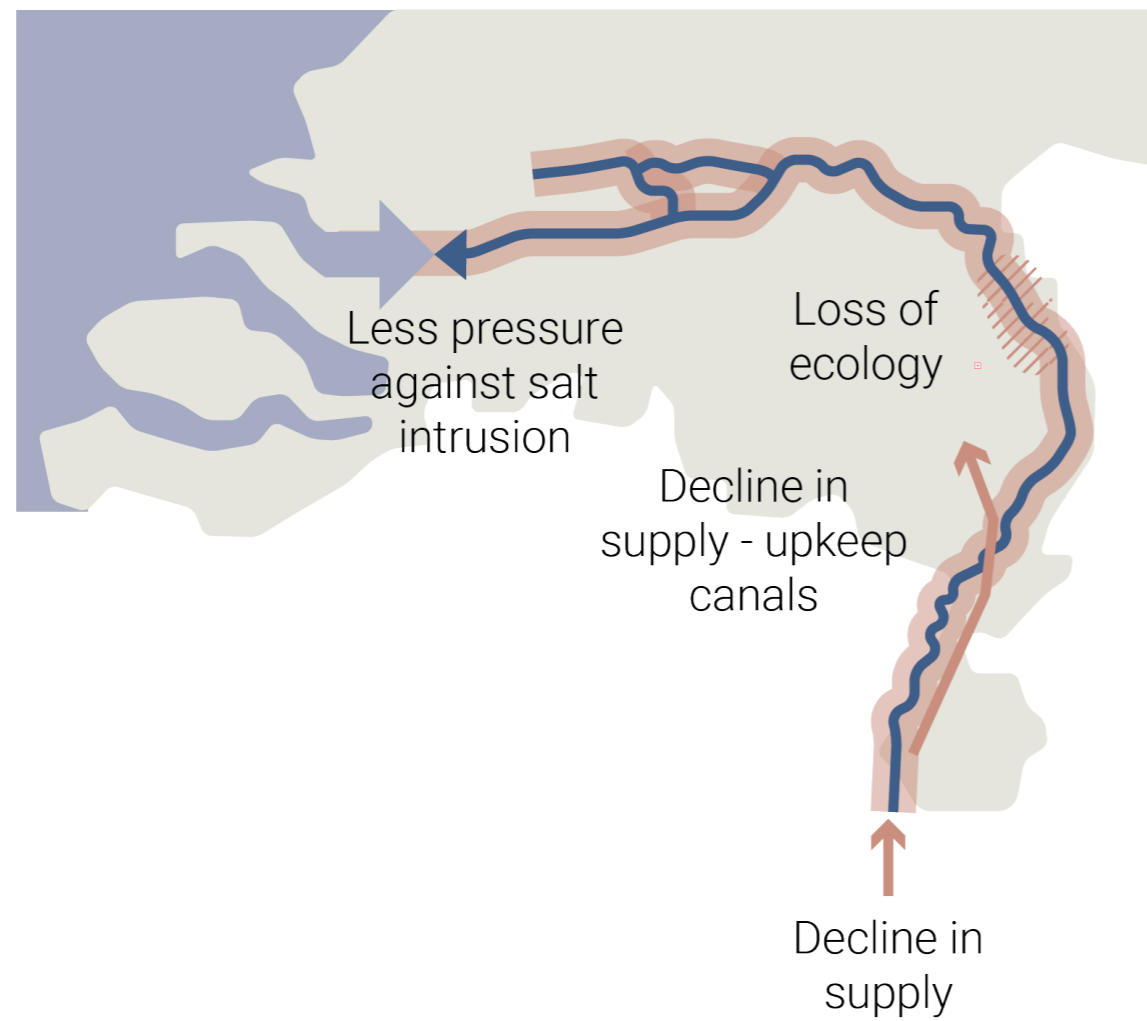
Based on Klimateffectatlas (2025).

Rain-fed rivers: the Maas



Problematisation

Consequences of climate change





Maas canalisation at Balgoij and Keent
Source: KLM Aerocarto 5/11/1938

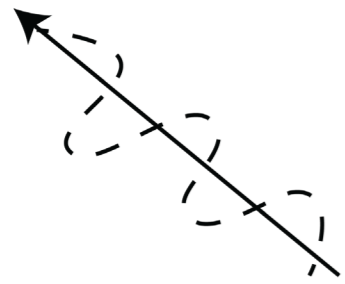
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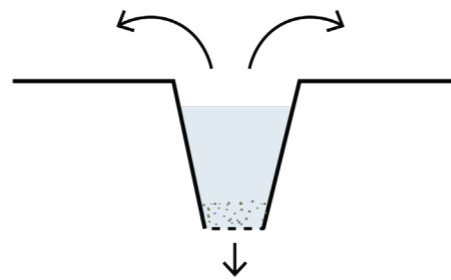
Weir complex Belfeld
Source: Author (2025)

Human interference

The Maas has lost space



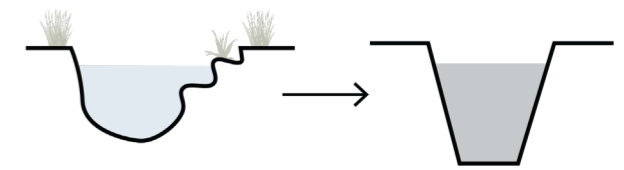
Summer bed is sinking



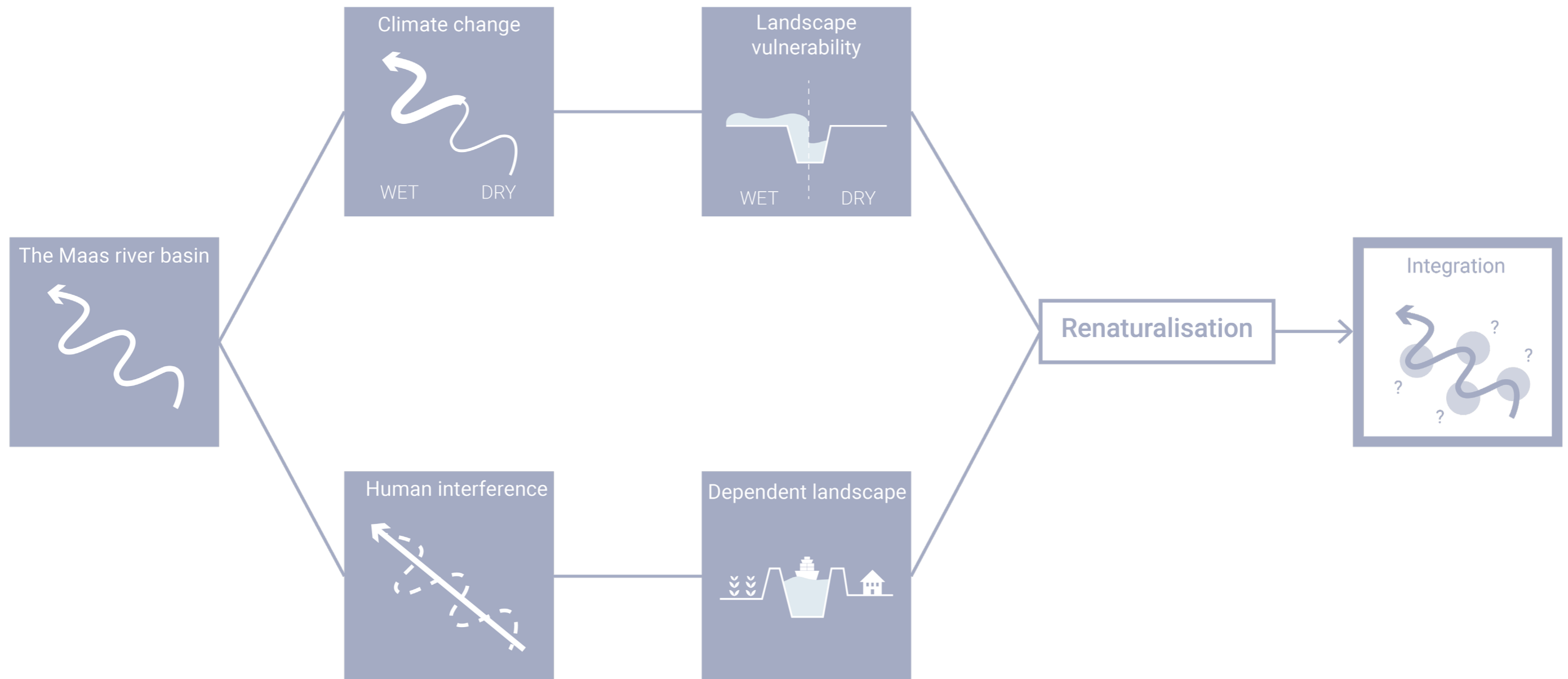
Low discharges are problematic

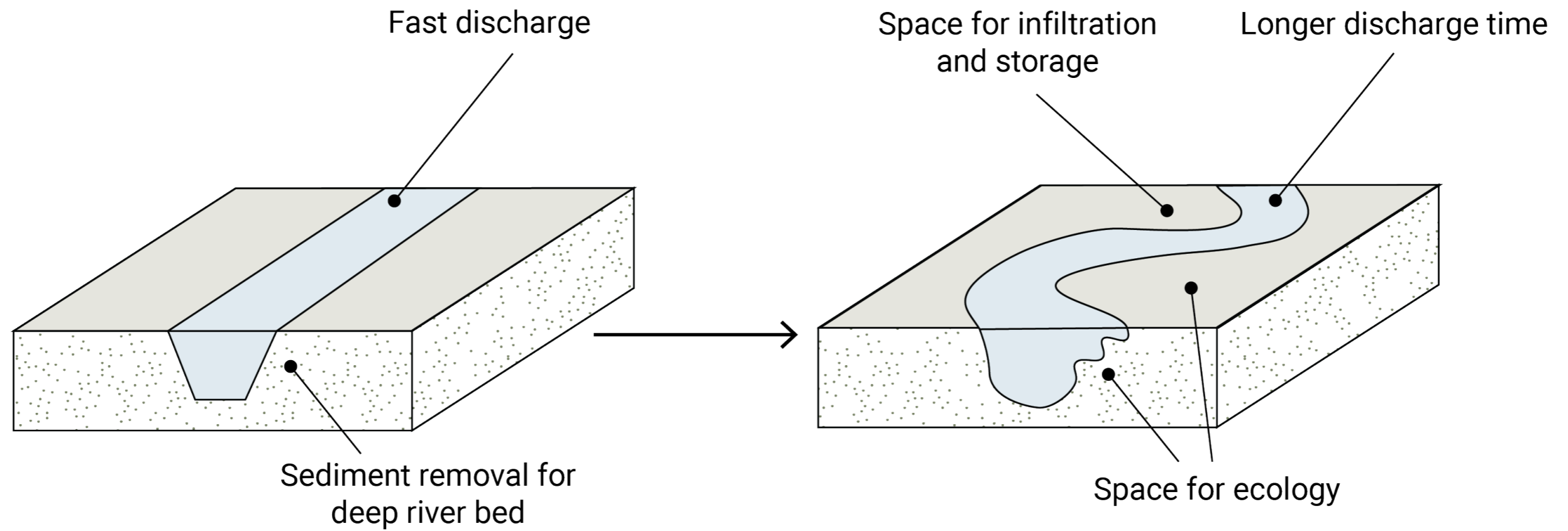


River nature is lost



Problem framework





Renaturalisation

Example: River Drau in Austria



Pre-restoration

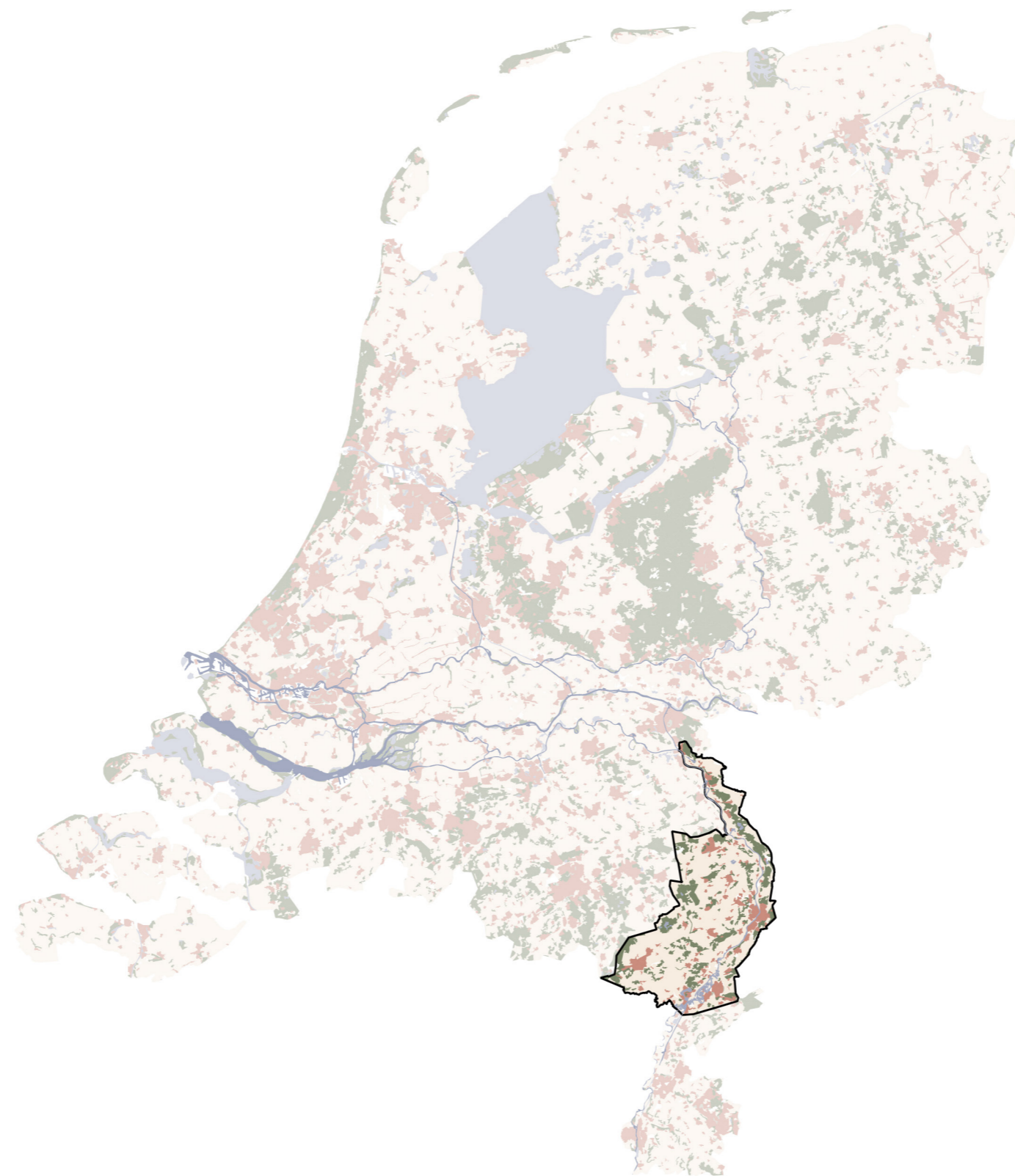


Post-restoration

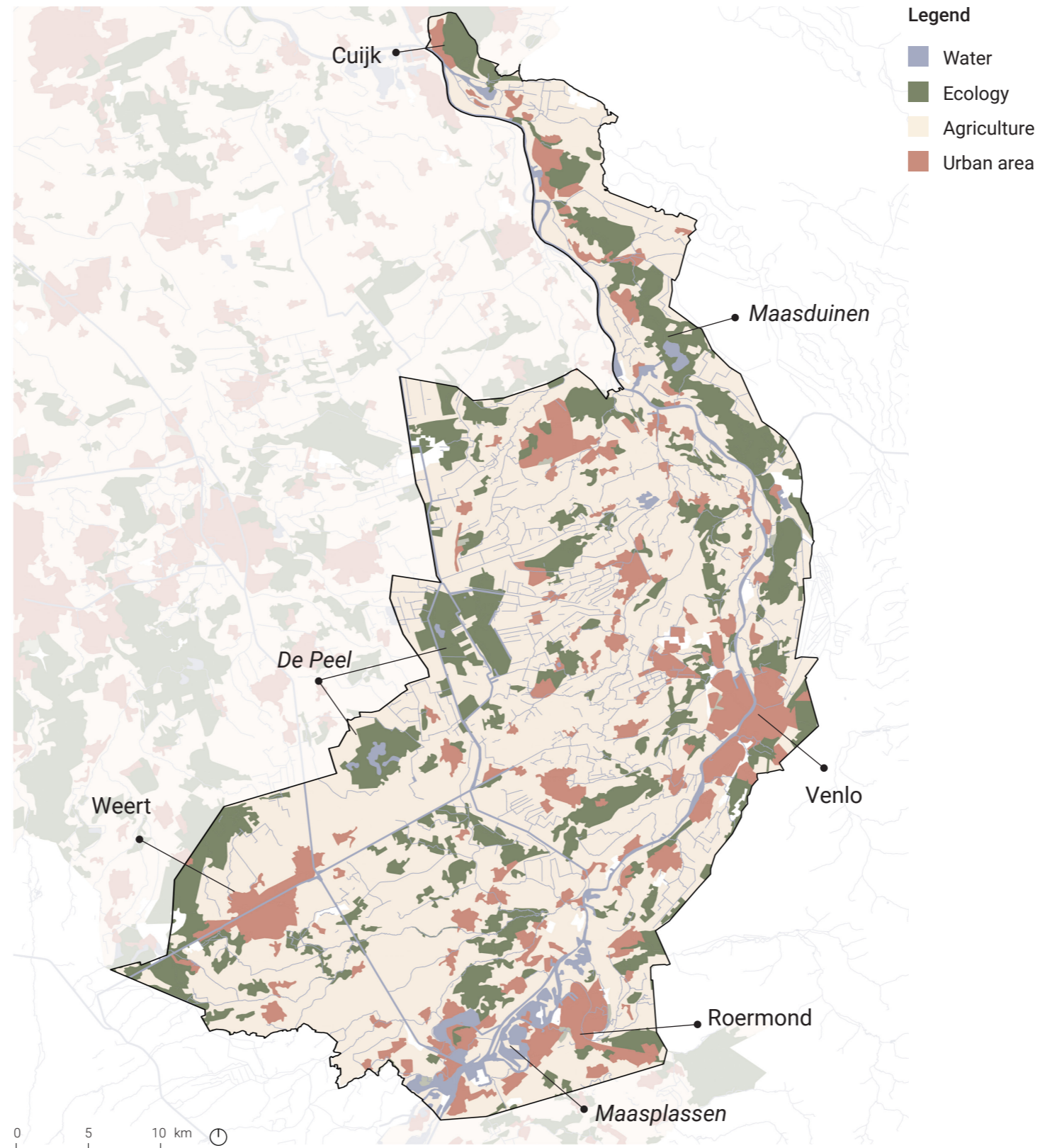
Source: Riverlab

How will renaturalisation of the river Maas as a climate resilience strategy transform the **Noordelijke Maasvallei** under the most **extreme dry and wet scenarios** by **2100**, and how can the **ecological, agricultural, and urban** landscape evolve with this transformation?

The Noordelijke Maasvallei



The Noordelijke Maasvallei





Roermond
Source: Author (2025)



Venlo
Source: Author (2025)



The Maasduinen
Source: Author (2025)

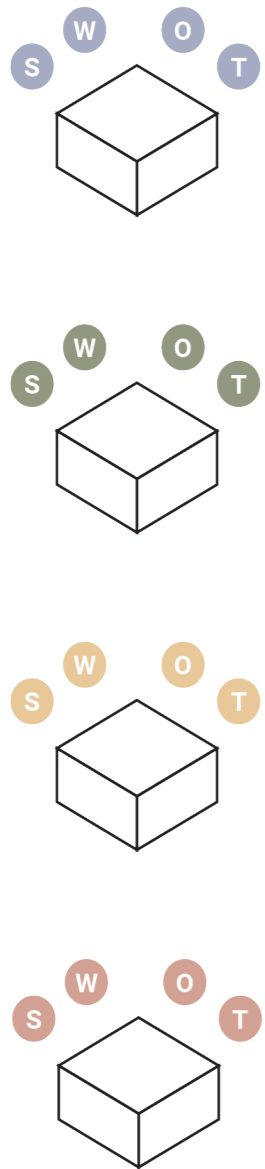


De Grootte Peel
Source: Author (2025)

Analysis

Analysis

SWOT



FAS



Pattern language



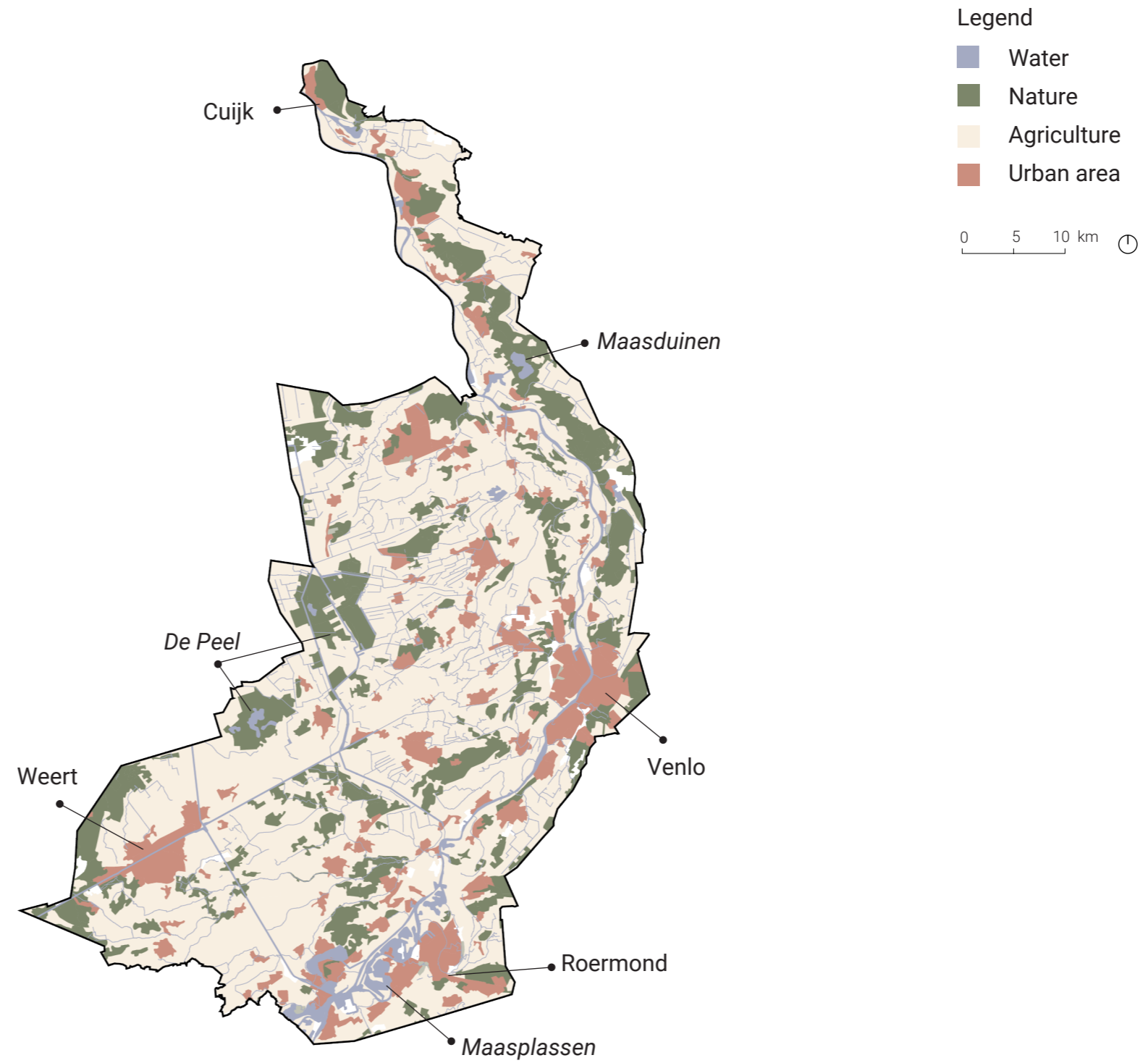
Maximisation



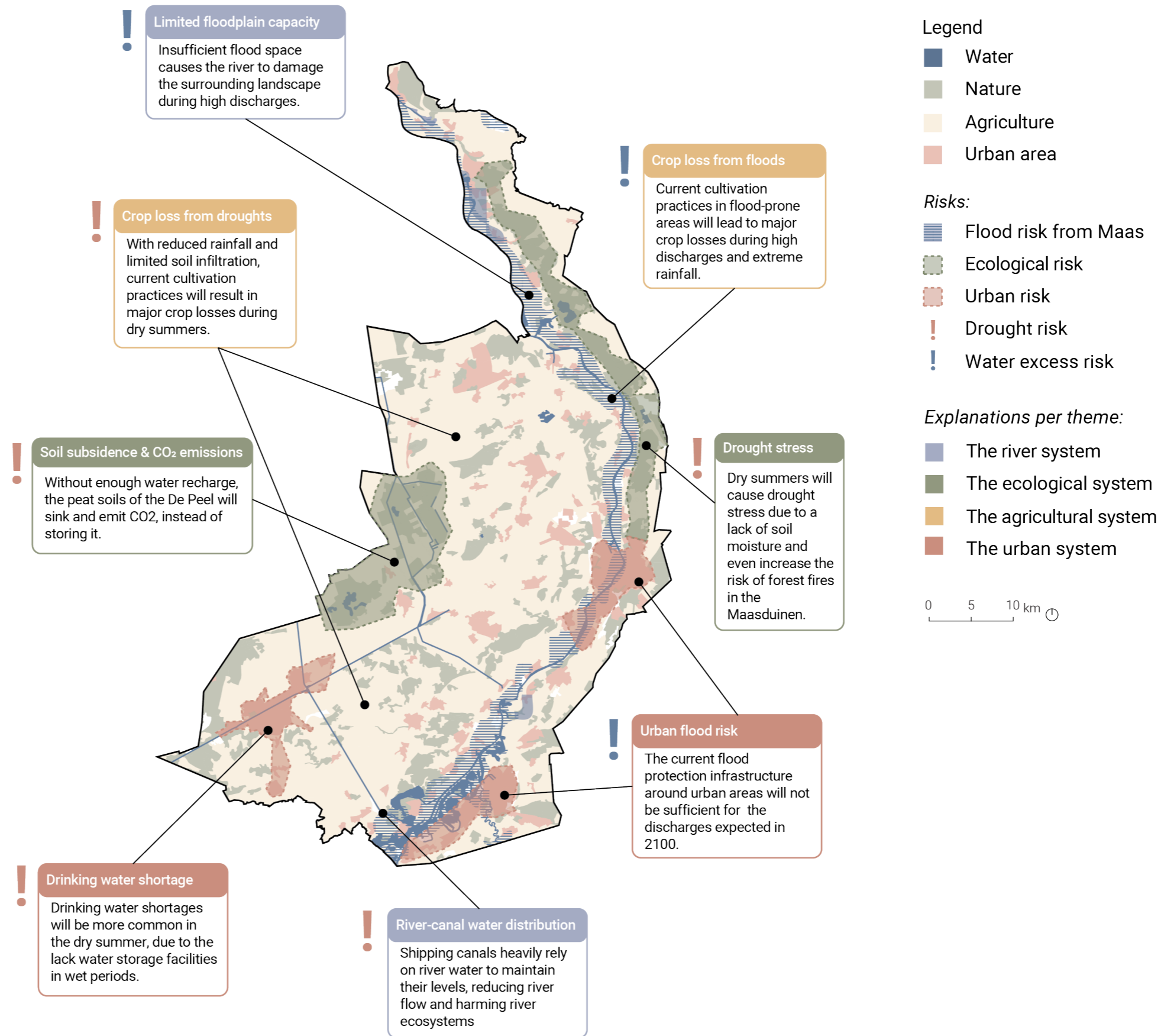
Integrated design



2025



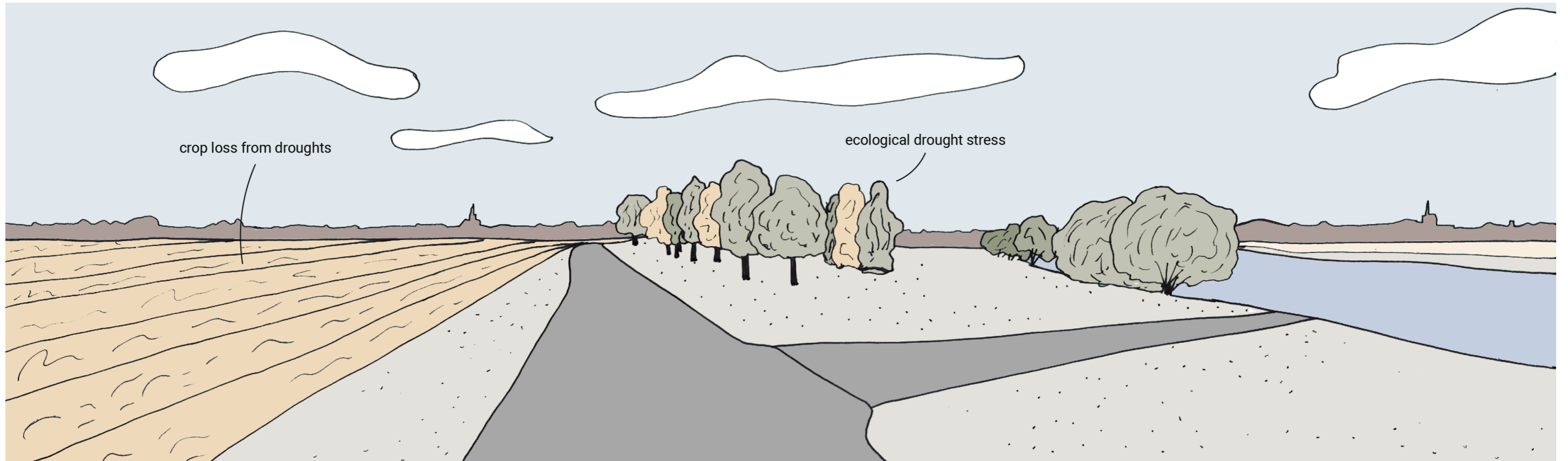
2100



Future Autonomous Situation

Rural - 2100

! Crop loss from droughts ! Drought stress



Future Autonomous Situation

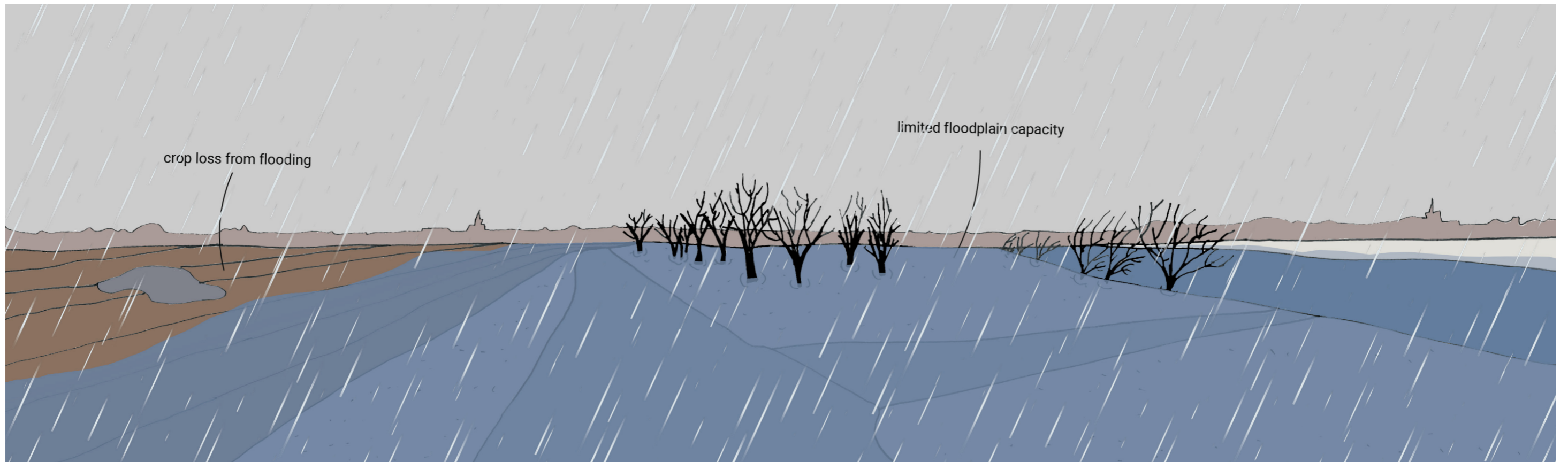
Rural - 2100



Crop loss from floods



Limited floodplain capacity

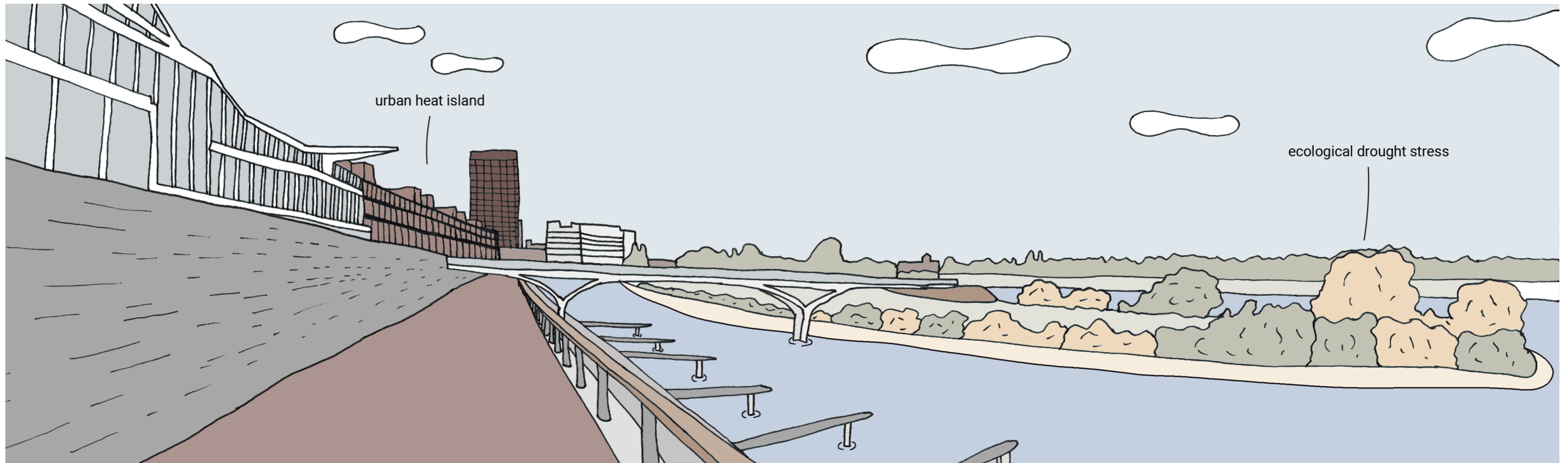


Future Autonomous Situation

Urban - 2100

! Drinking water shortage

! Drought stress



Future Autonomous Situation

Urban - 2100

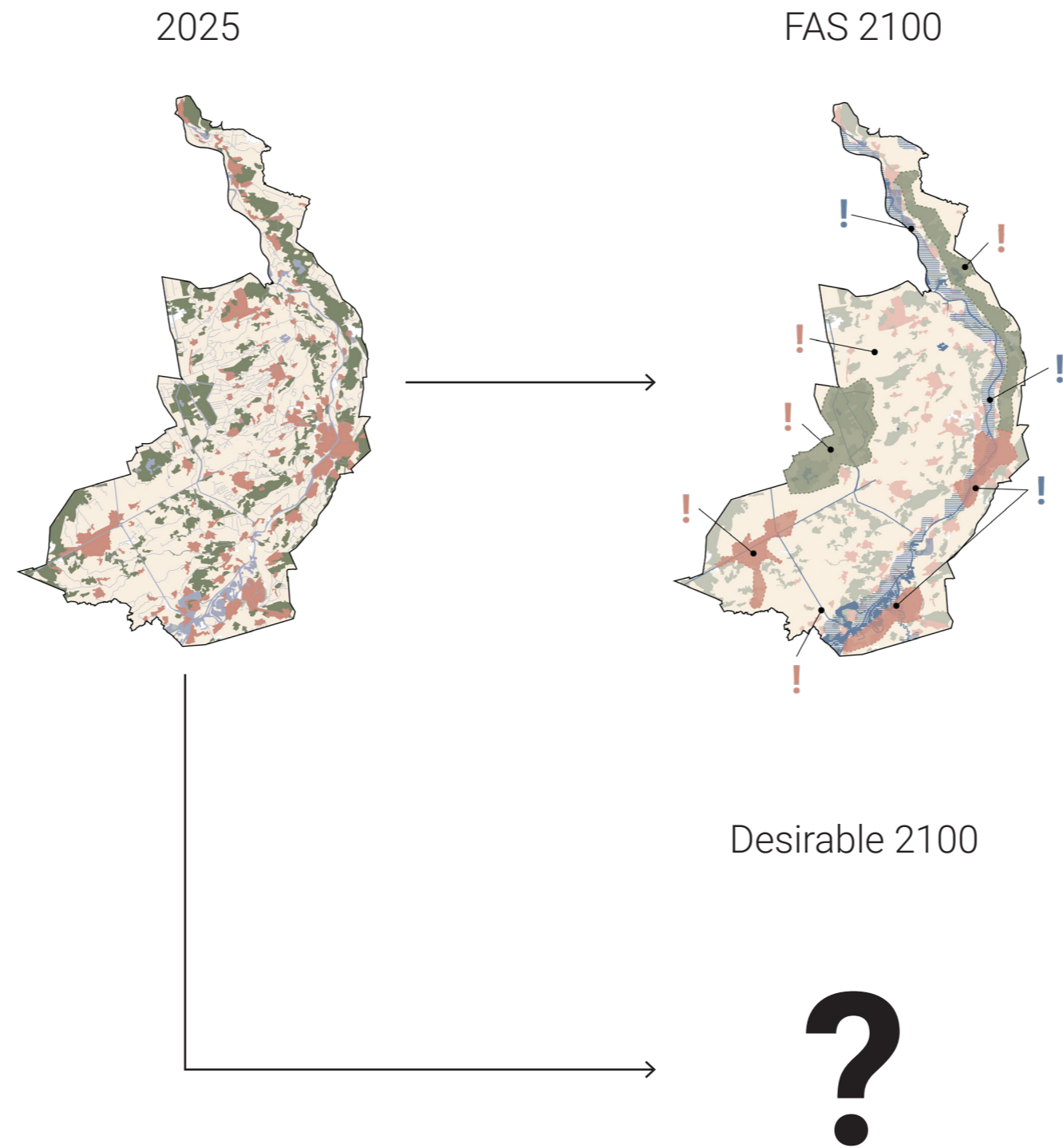


Urban flood risk



Limited floodplain capacity



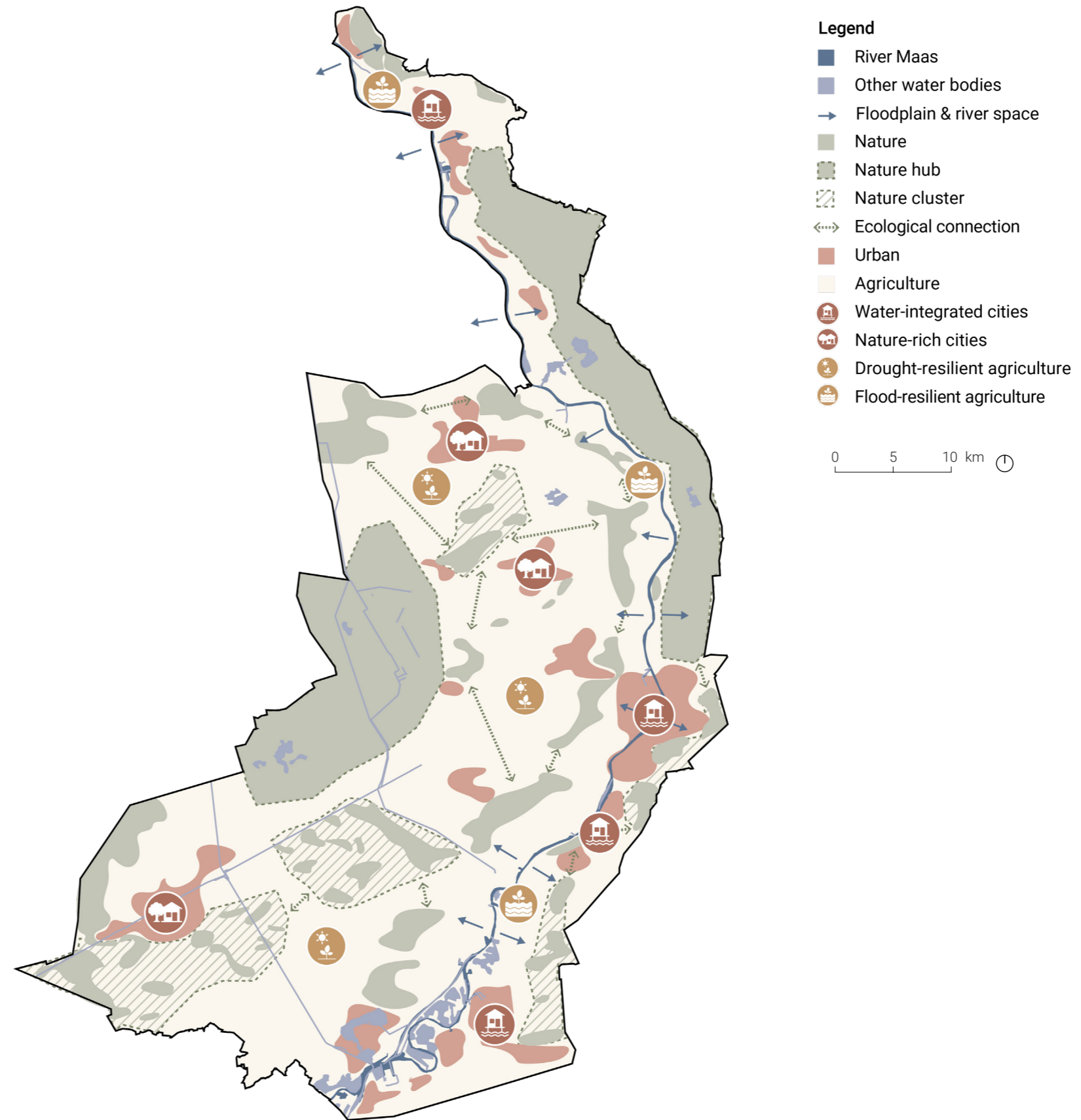


Renaturalised River

Expanded Ecology

Adaptive Agriculture

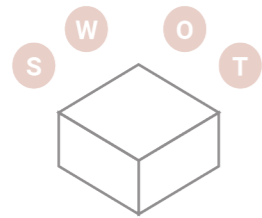
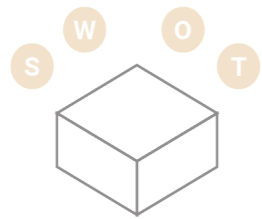
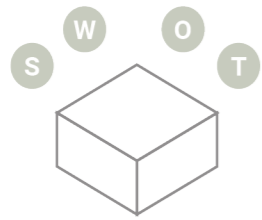
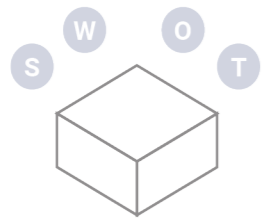
Climate-proof Cities



Design

Design

SWOT



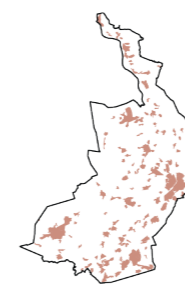
FAS



Pattern language



Maximisation

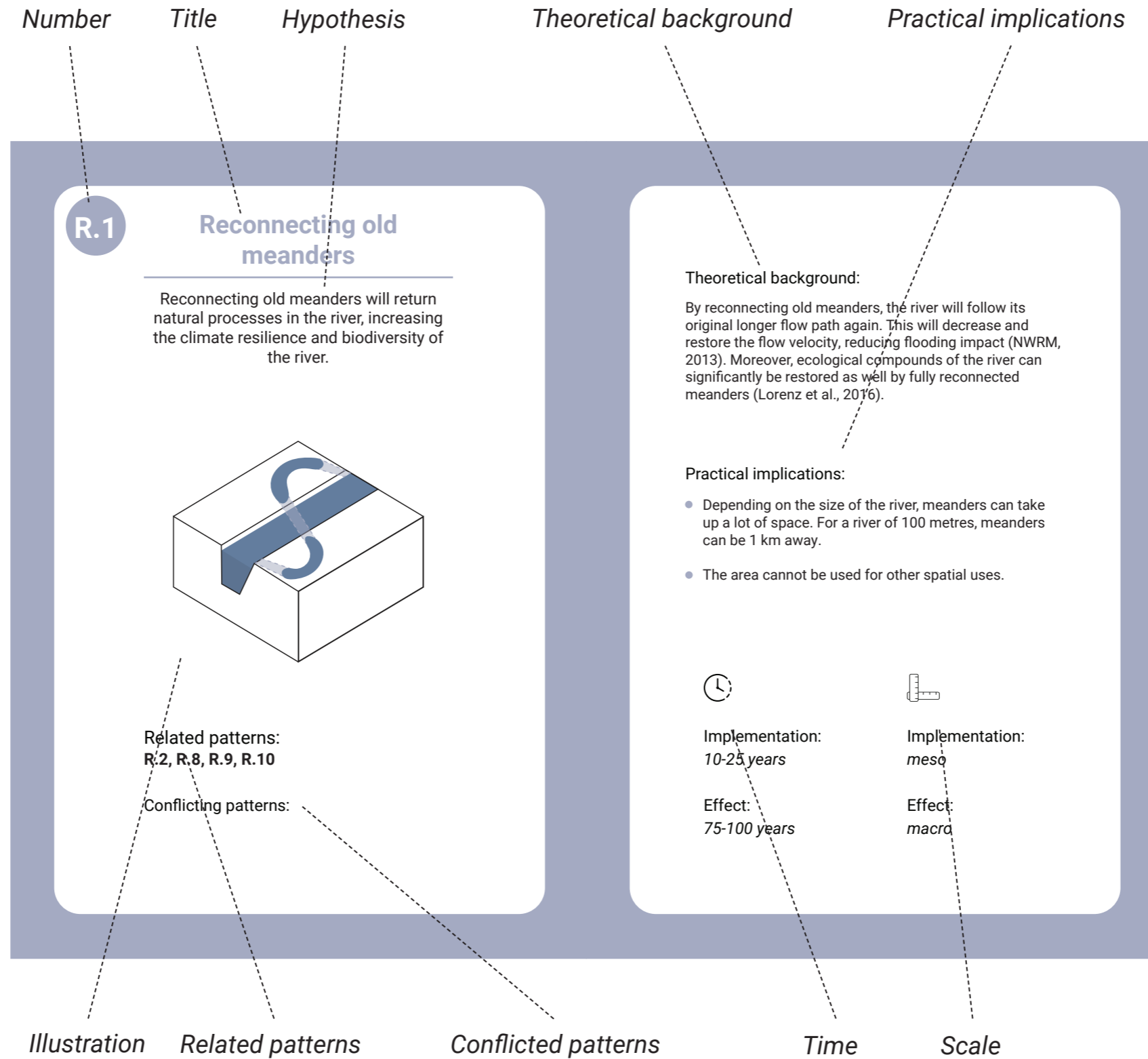


Integrated design



The pattern language

A pattern

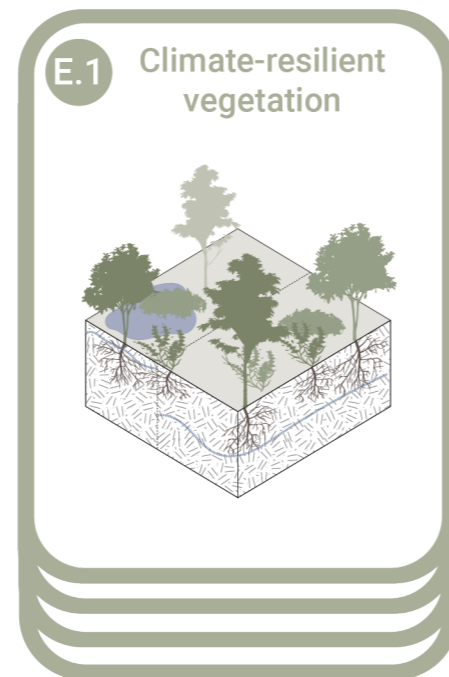


Pattern groups

Renaturalisation



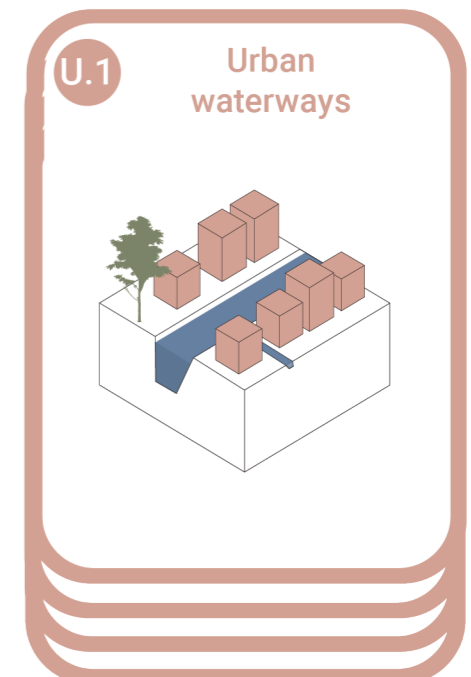
Ecology



Agriculture



Urbanisation



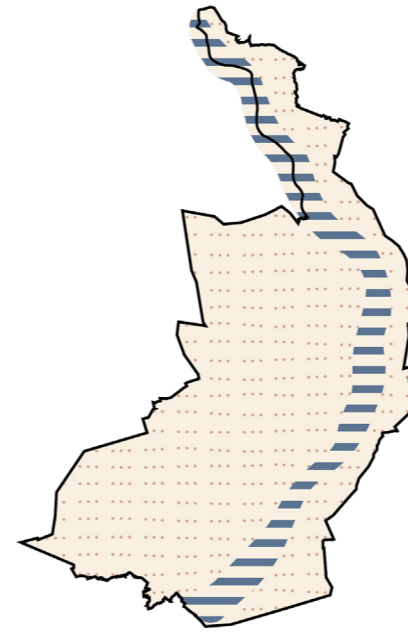
Renaturalised River



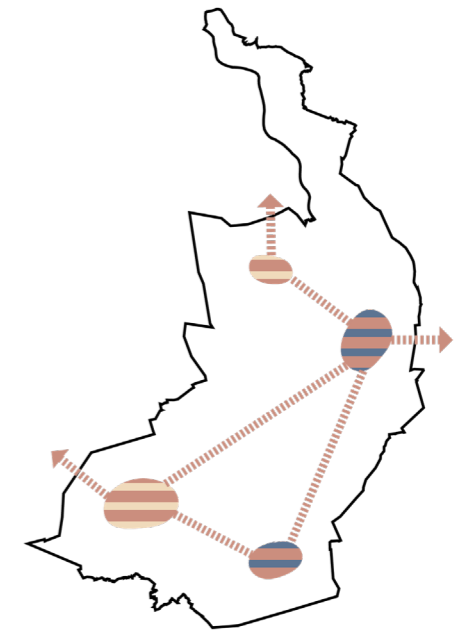
Expanded Ecology

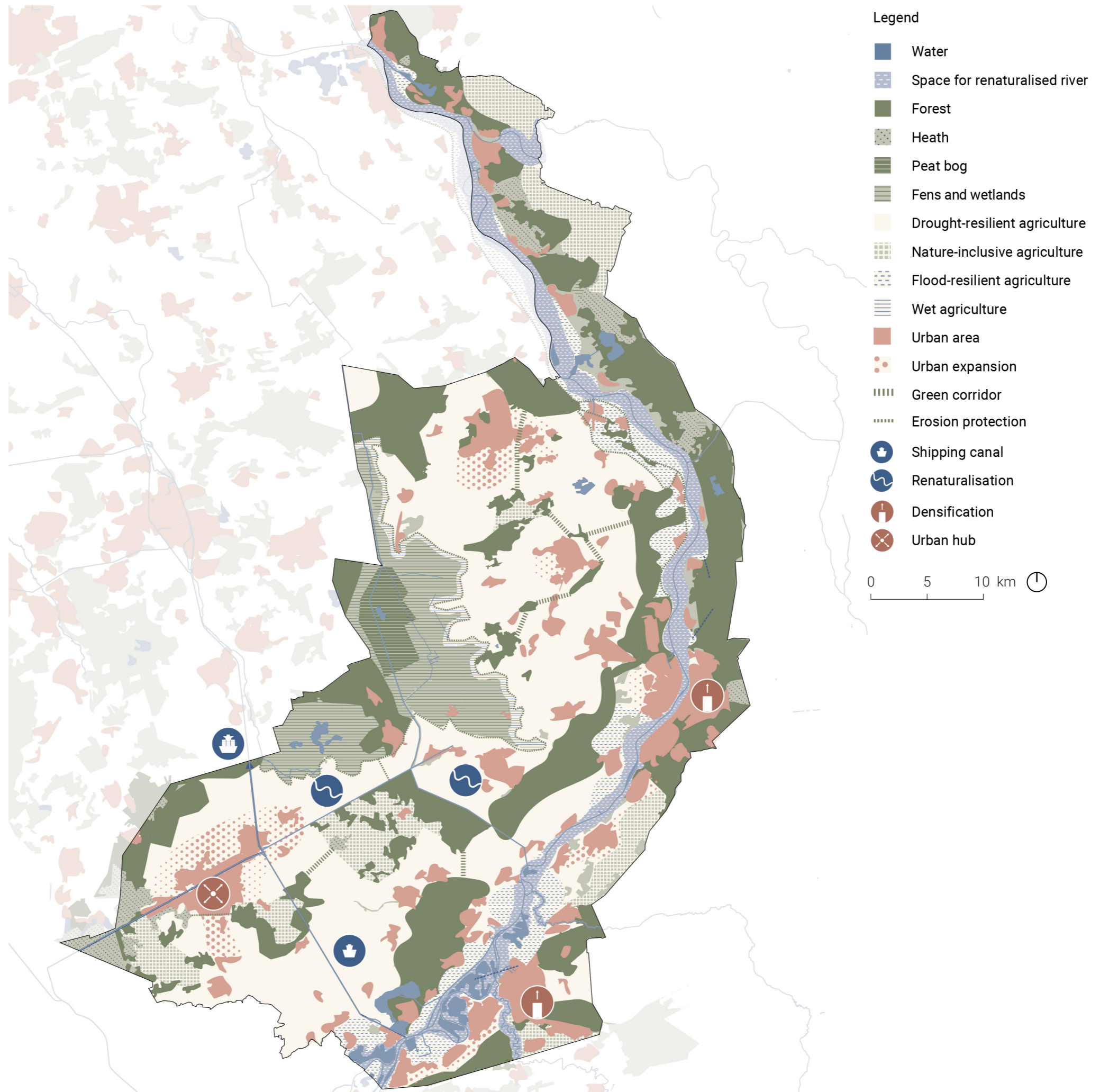


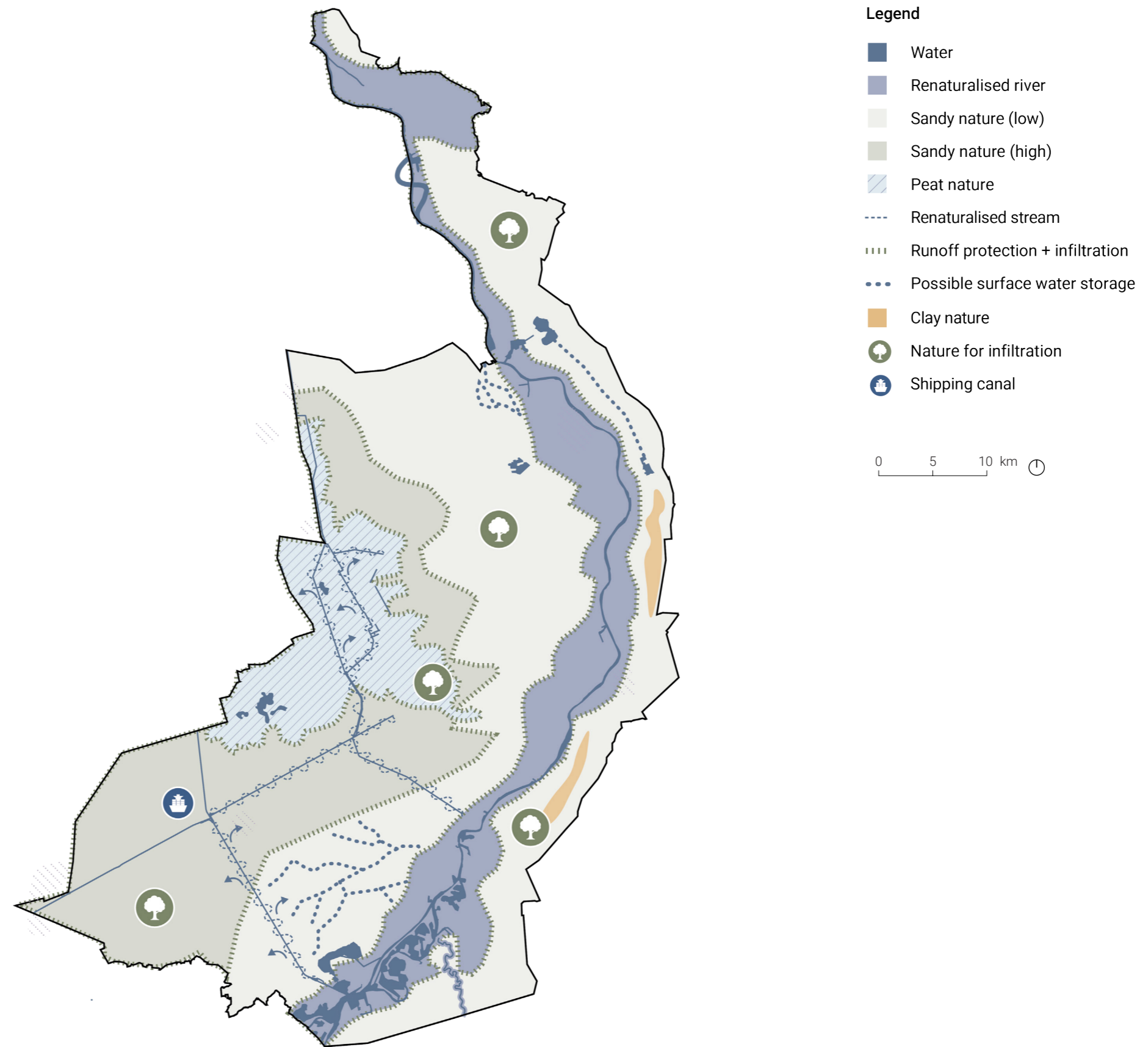
Adaptive Agriculture



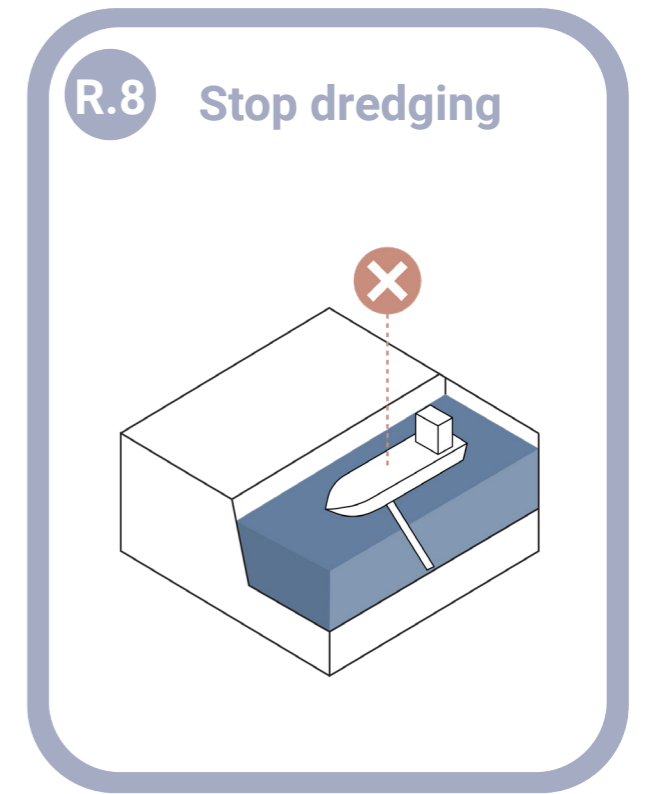
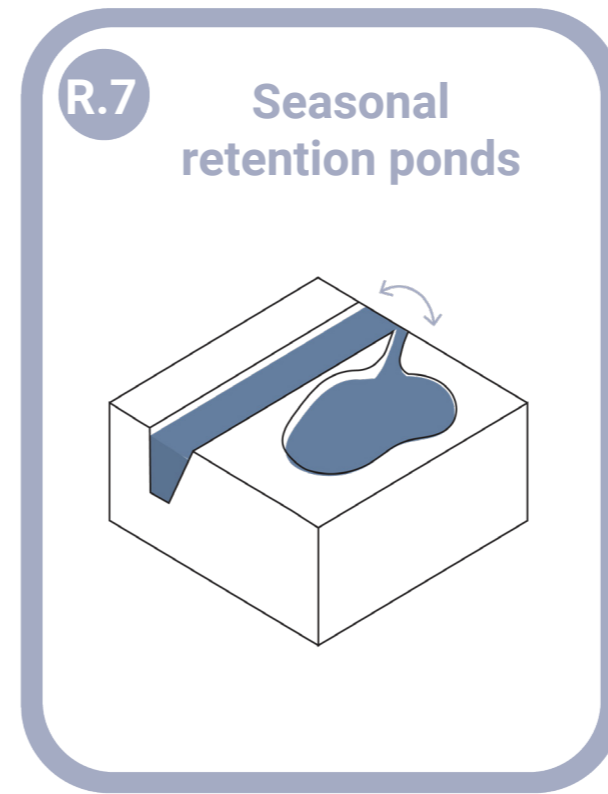
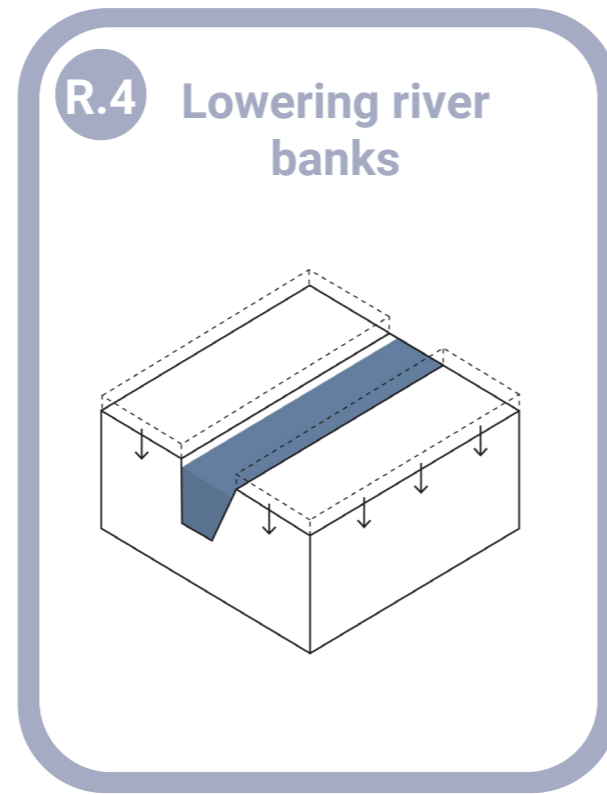
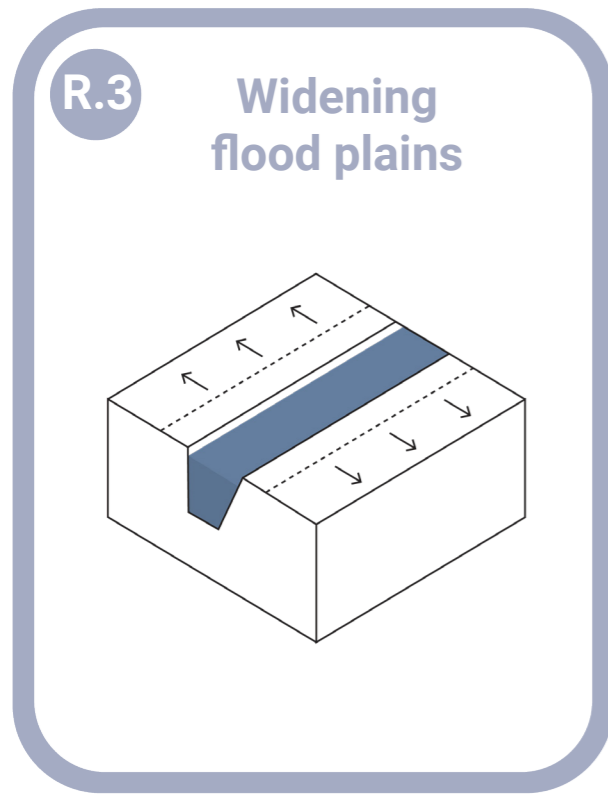
Climate-proof Cities





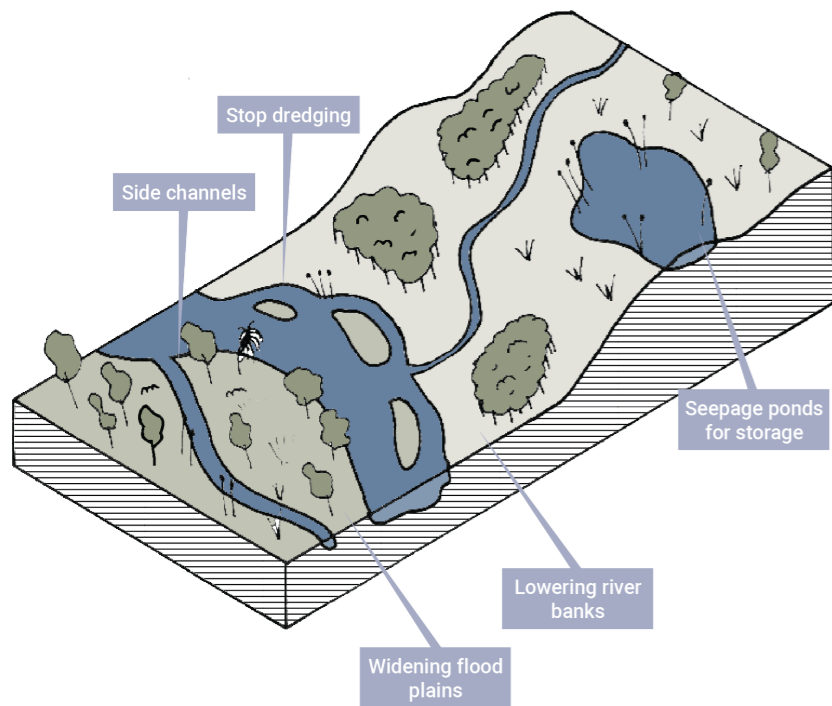


Patterns

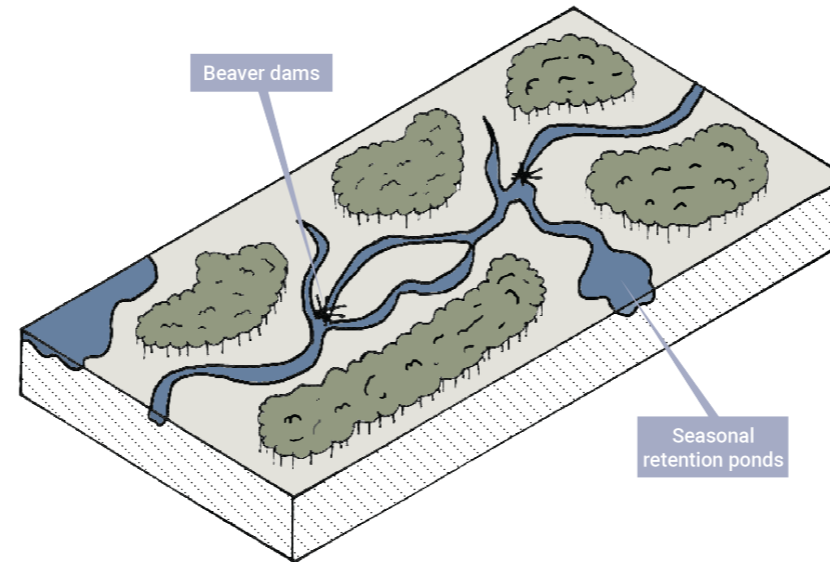


Zoom-ins

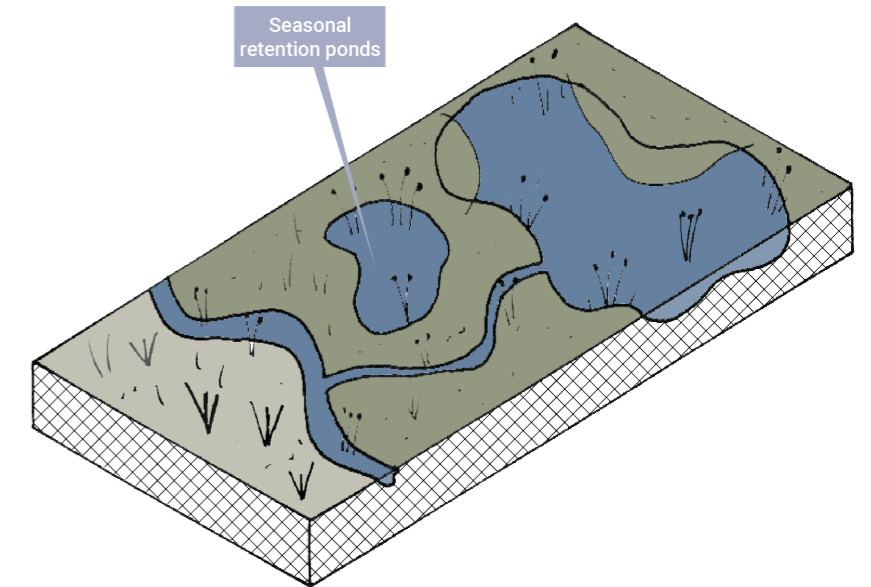
River landscape

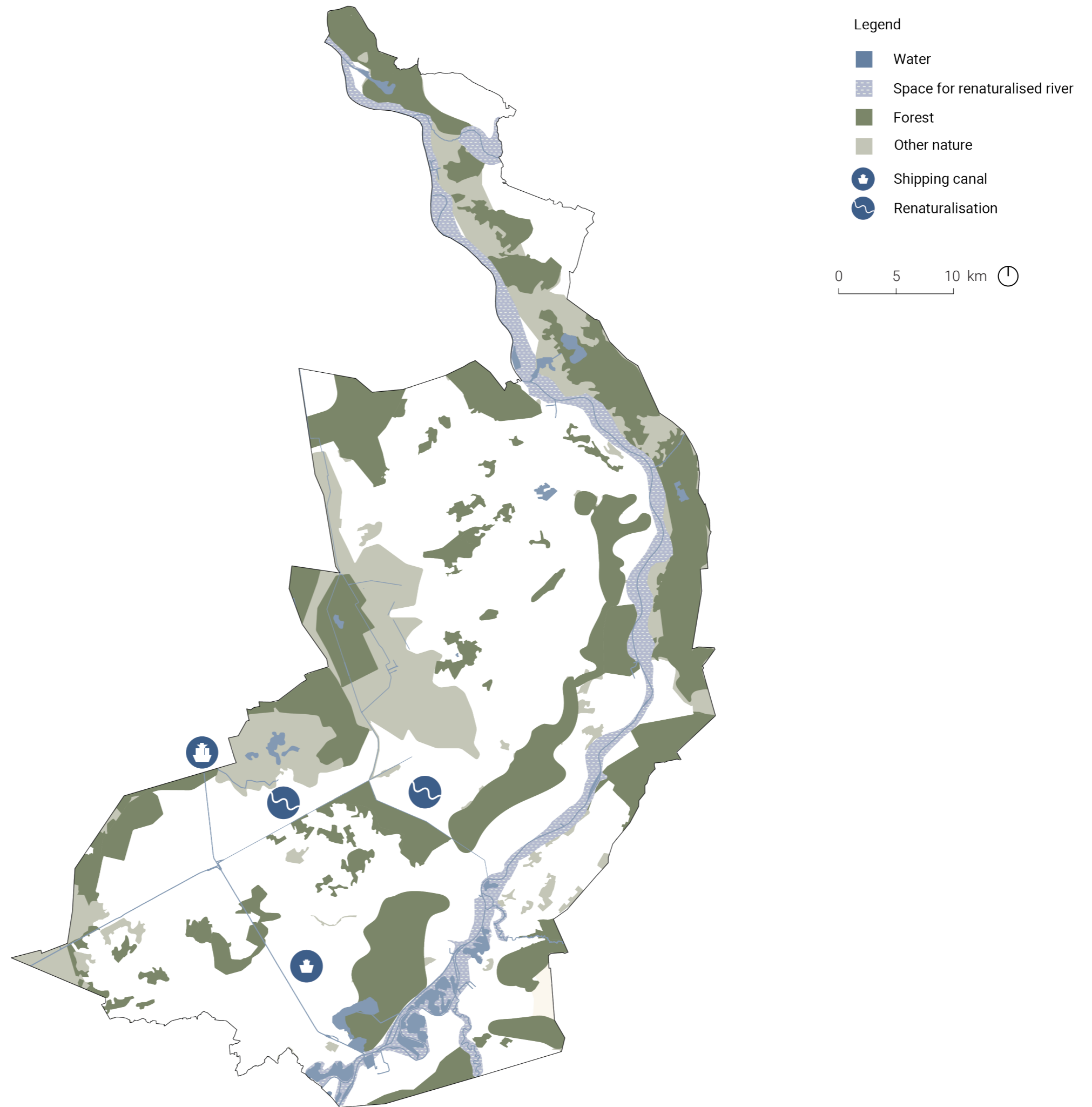


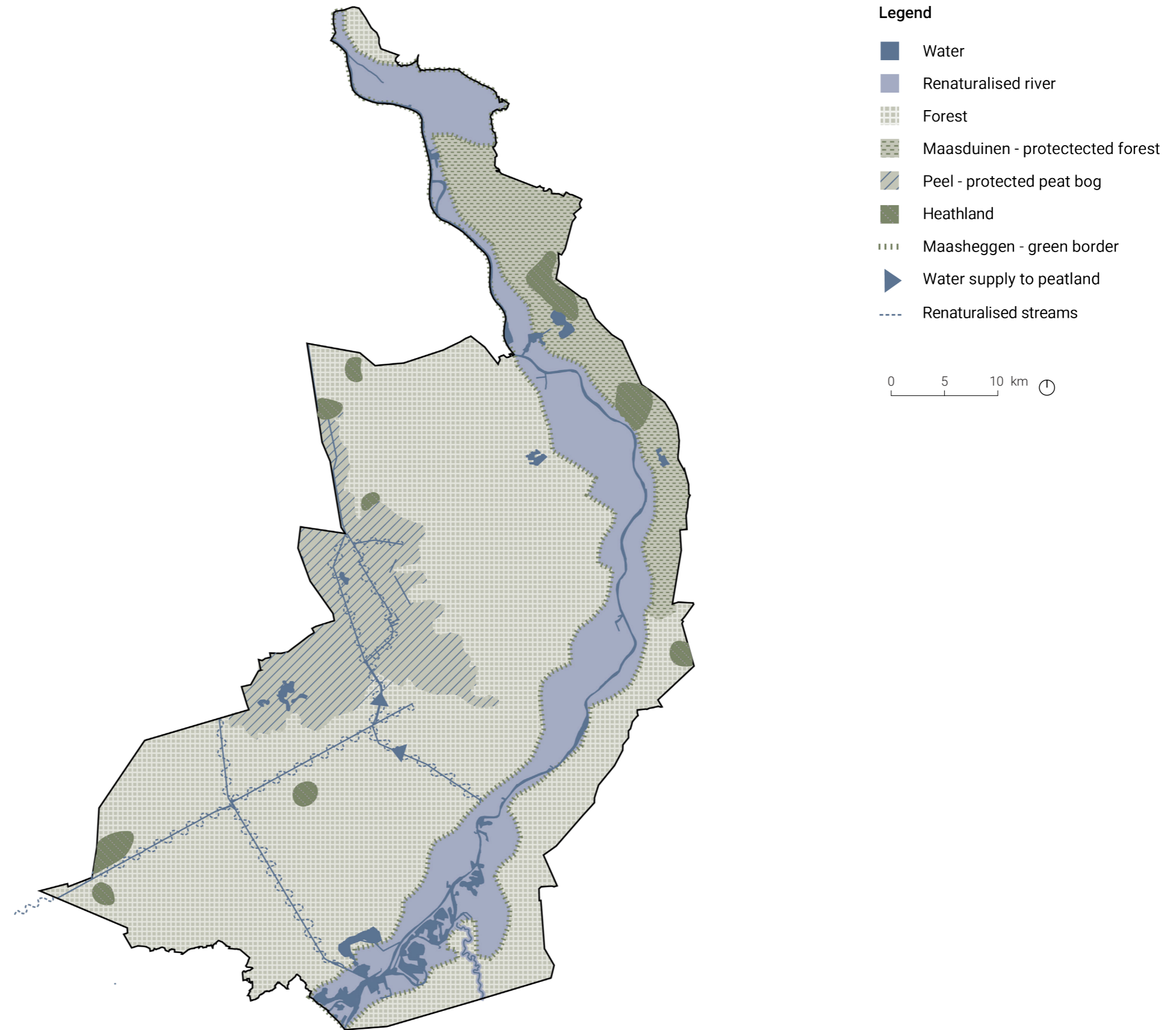
Sandy soils



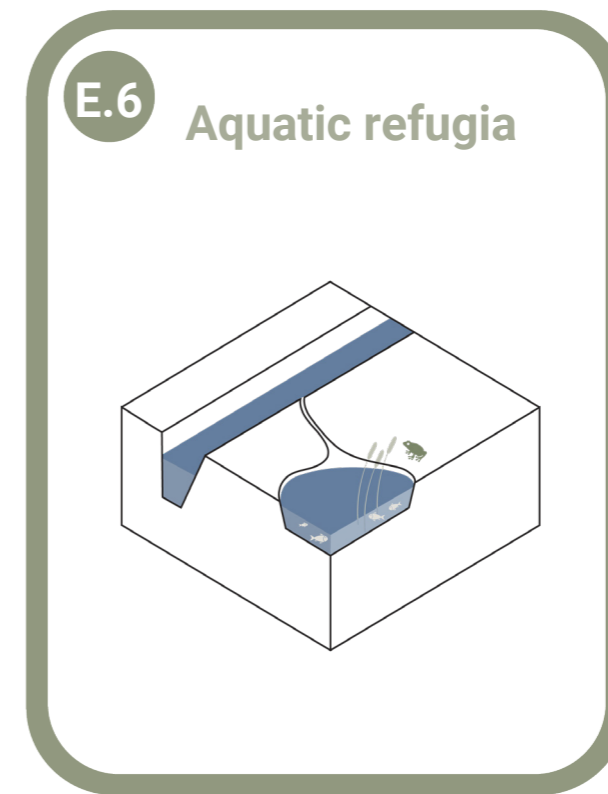
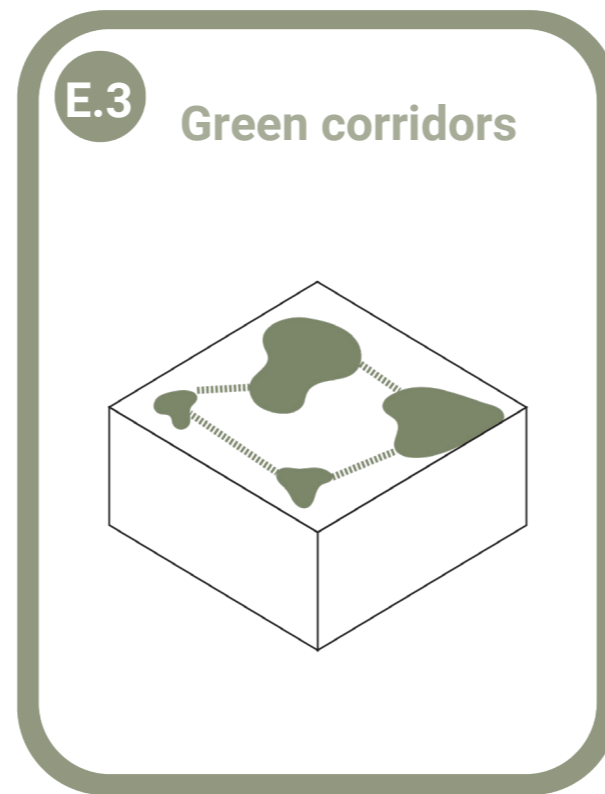
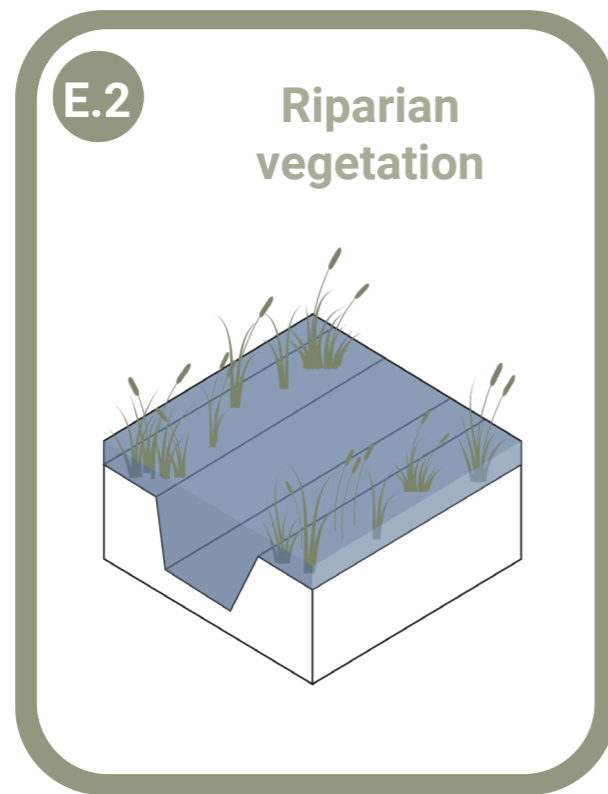
Peatland







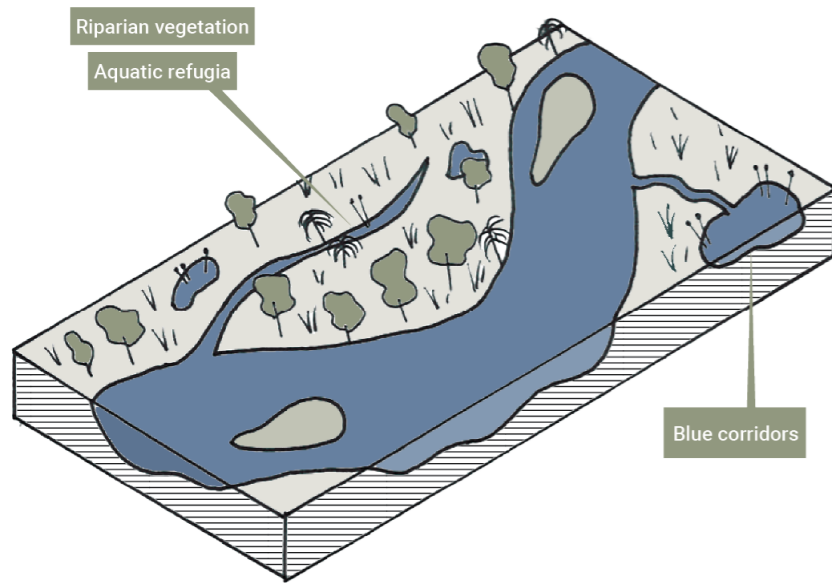
Patterns



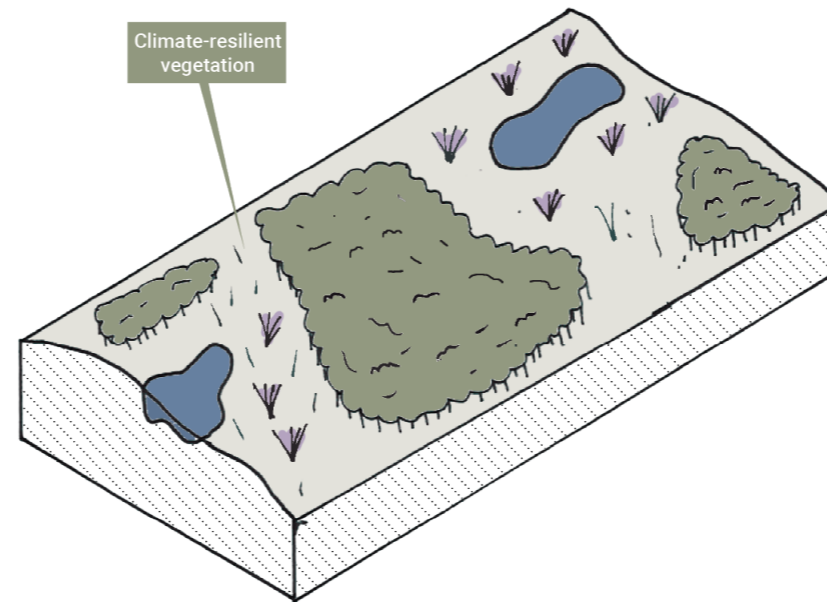
Maximise for ecology

Zoom-ins

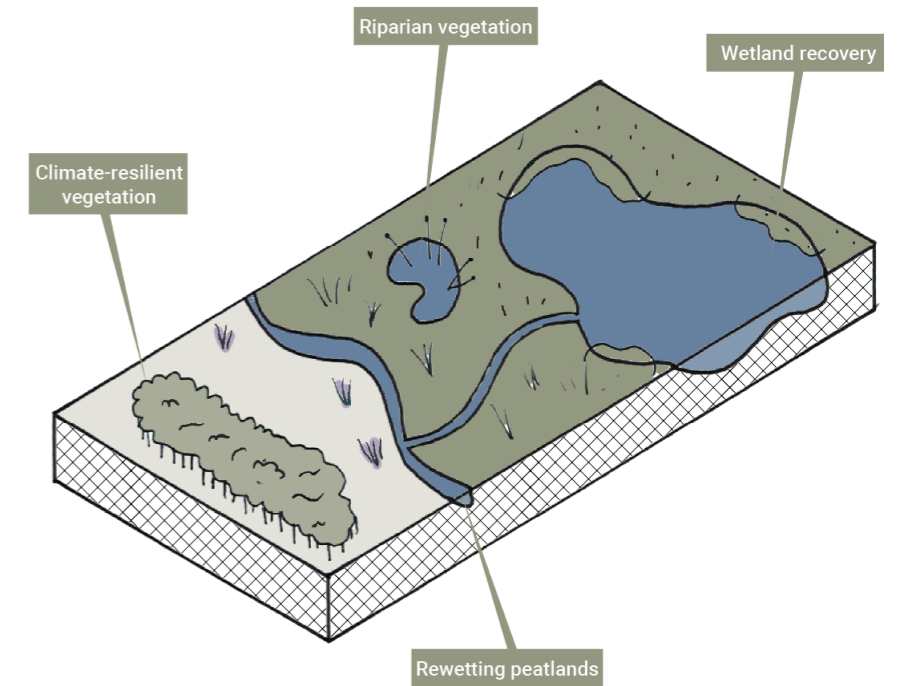
River landscape



Sandy soils

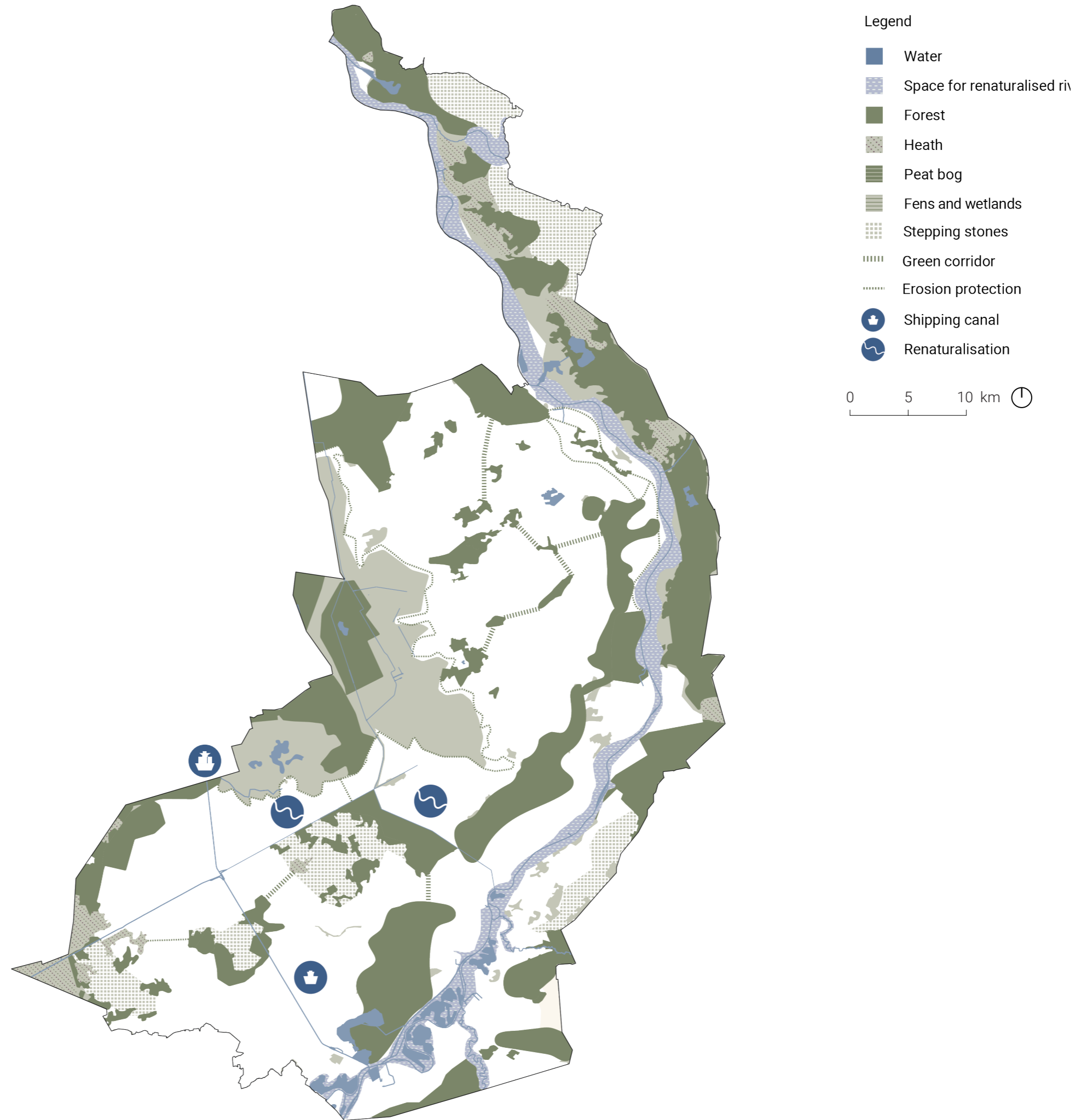


Peatland

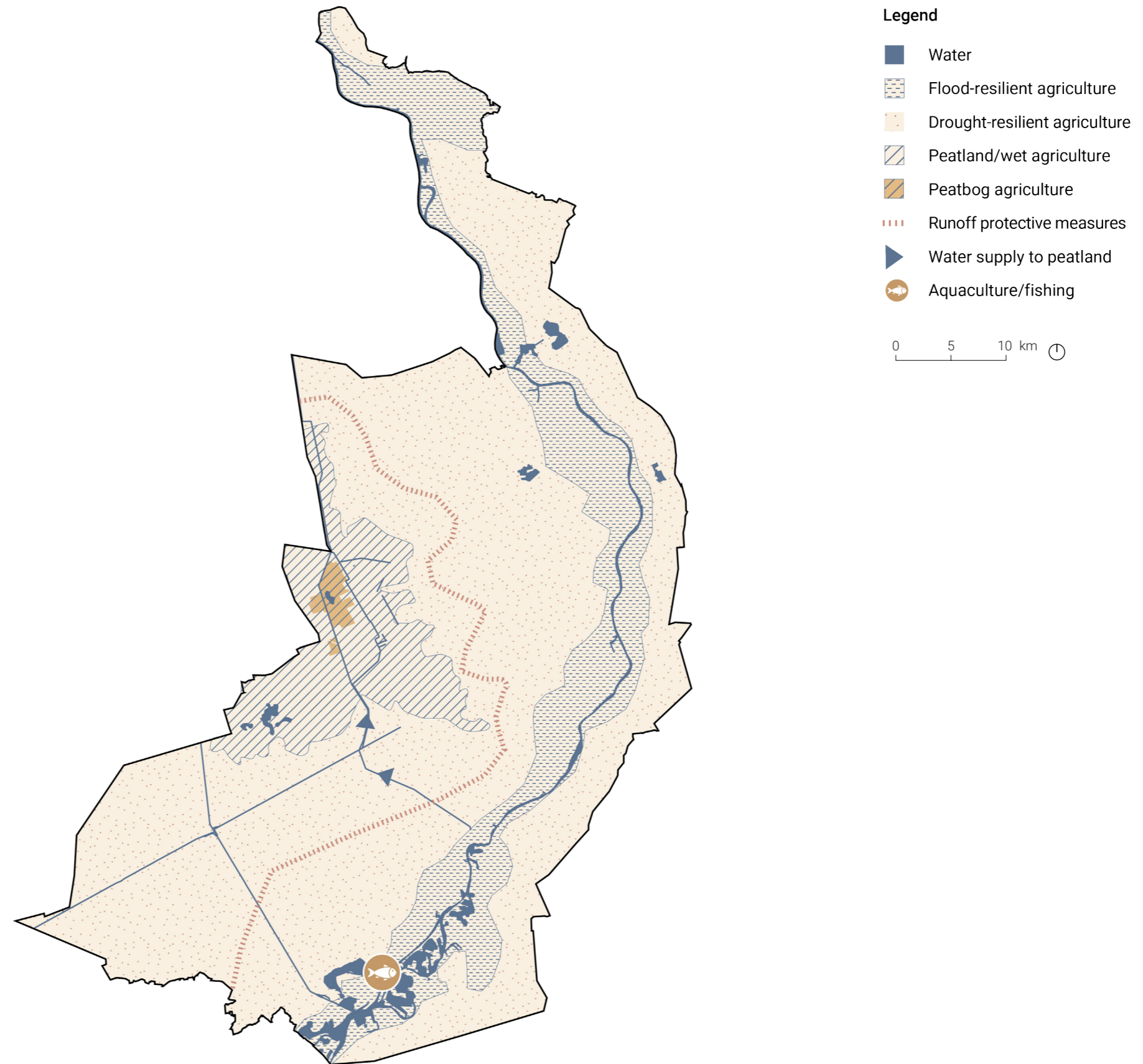


Renaturalised River

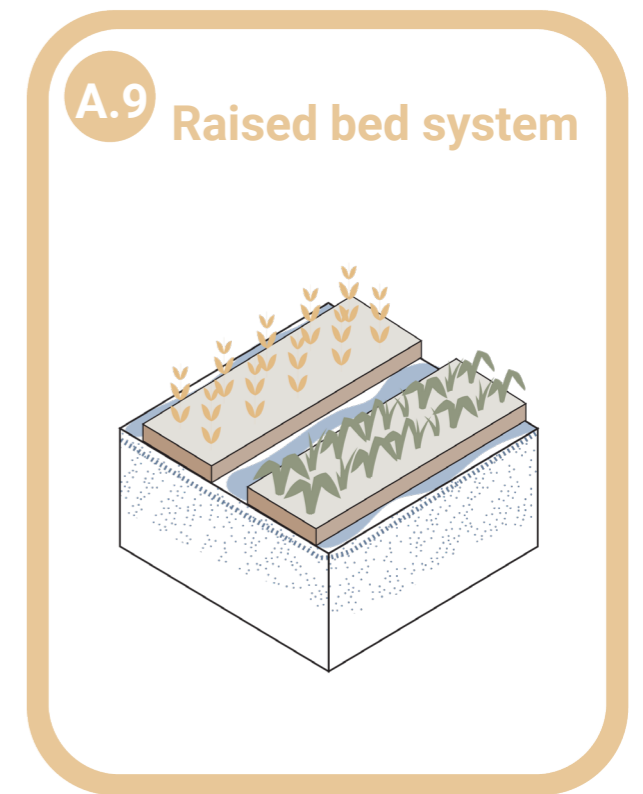
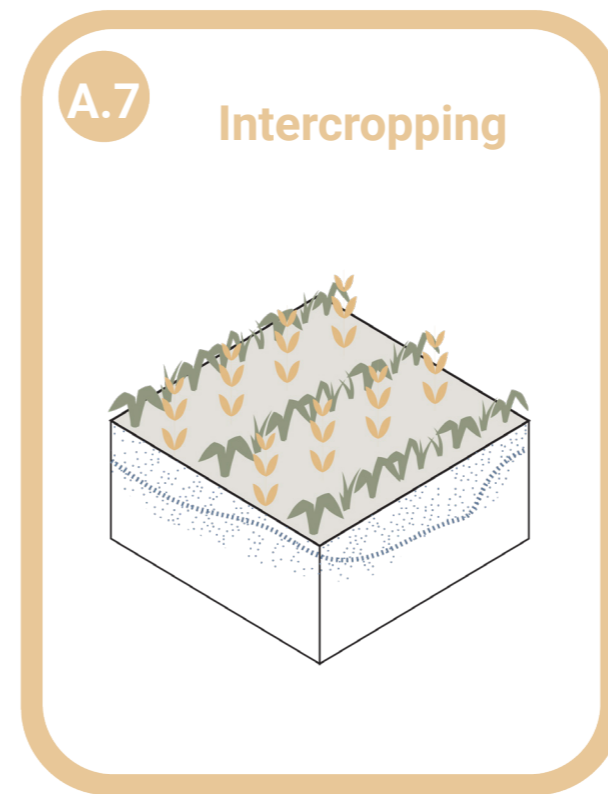
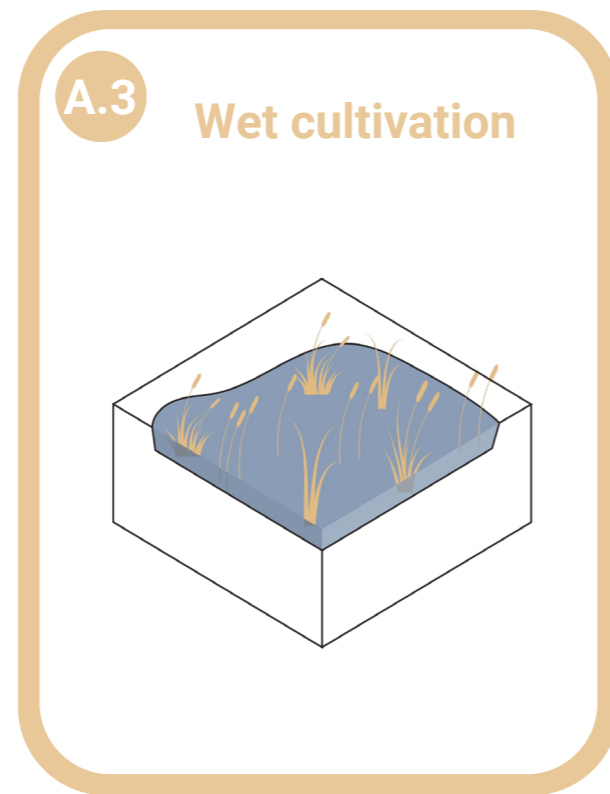
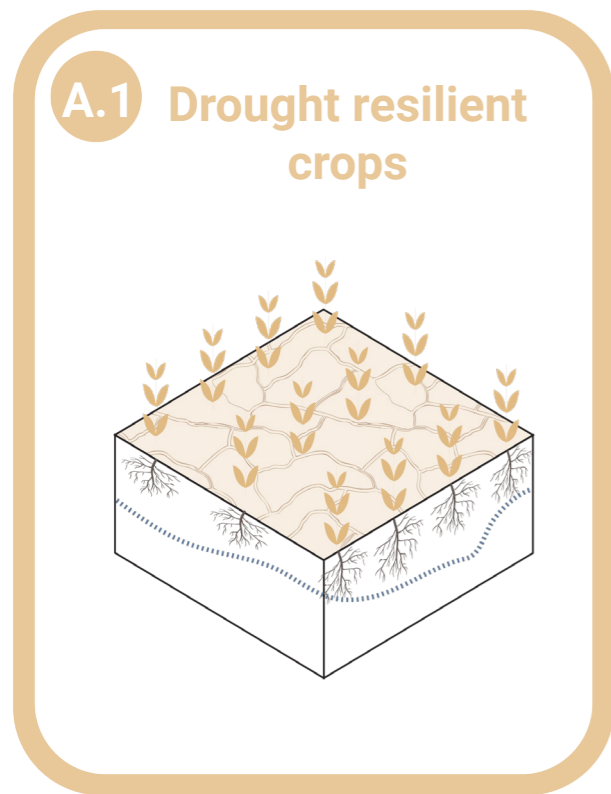
Expanded Ecology



Maximise for agriculture

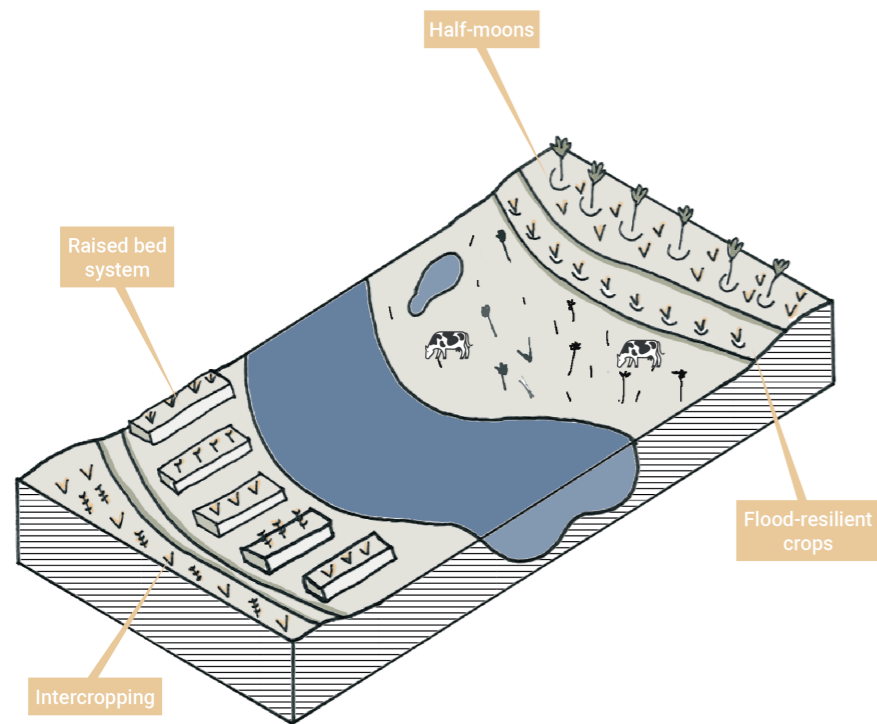


Patterns

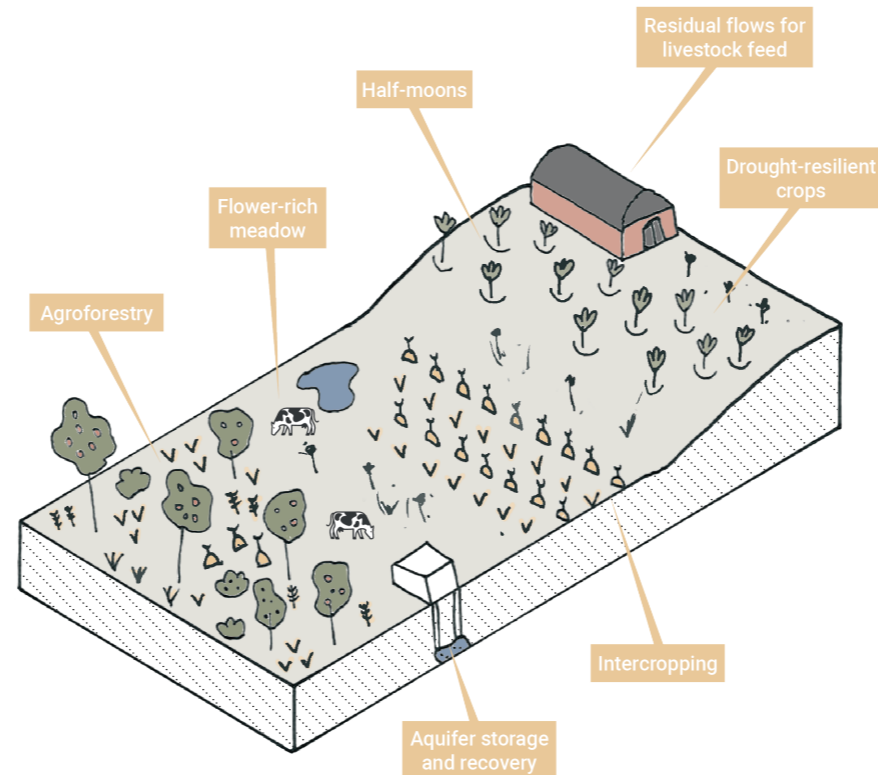


Zoom-ins

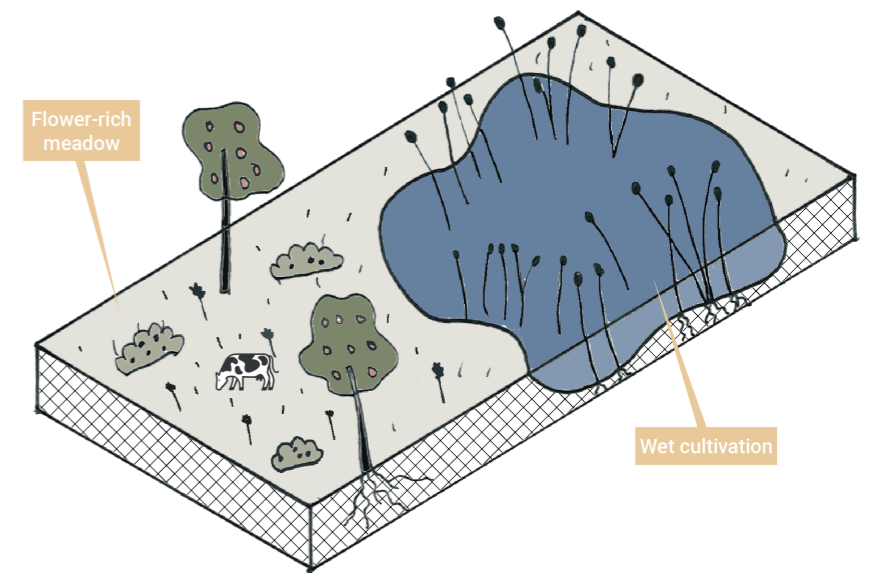
River landscape



Sandy soils



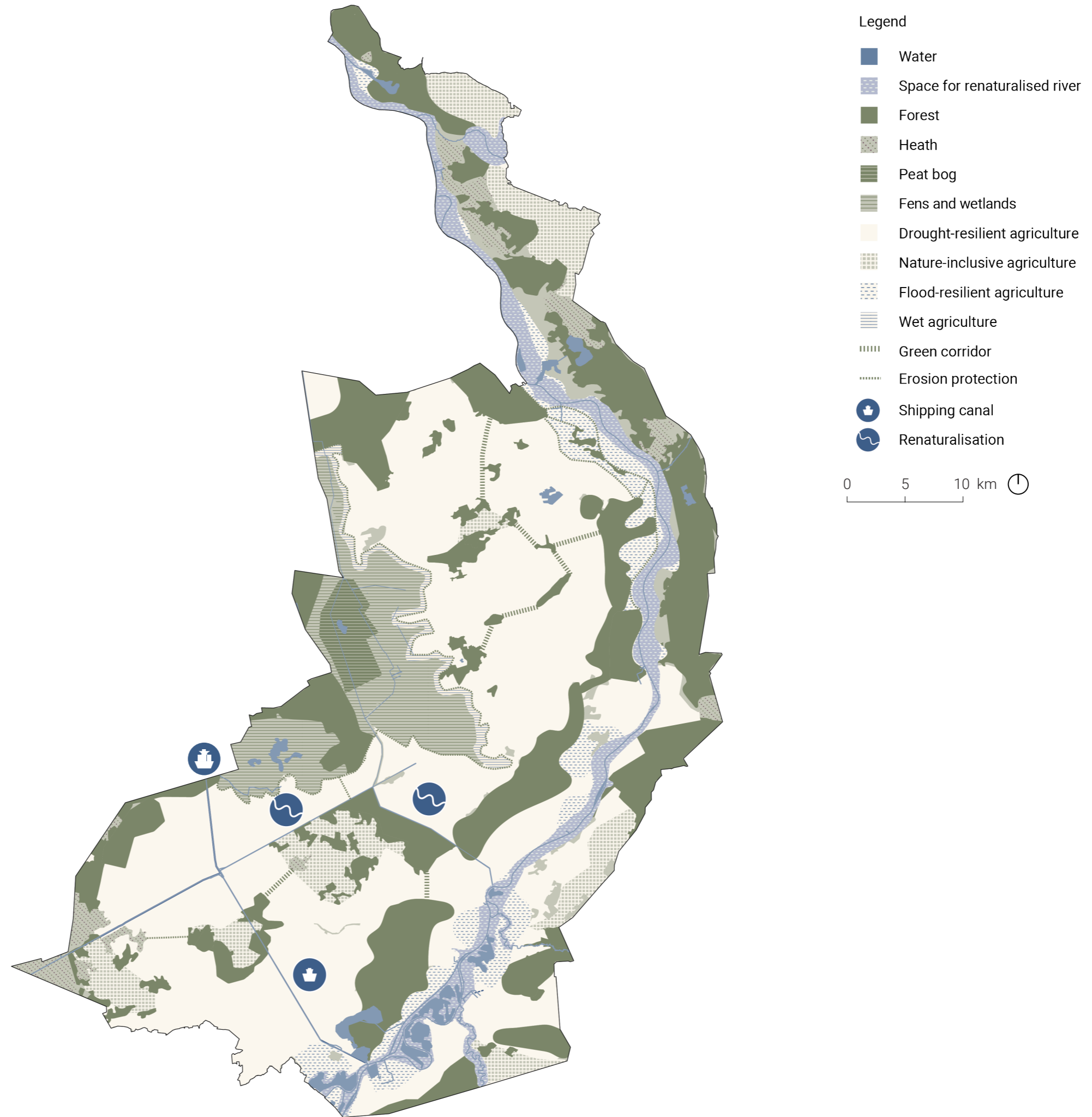
Peatland

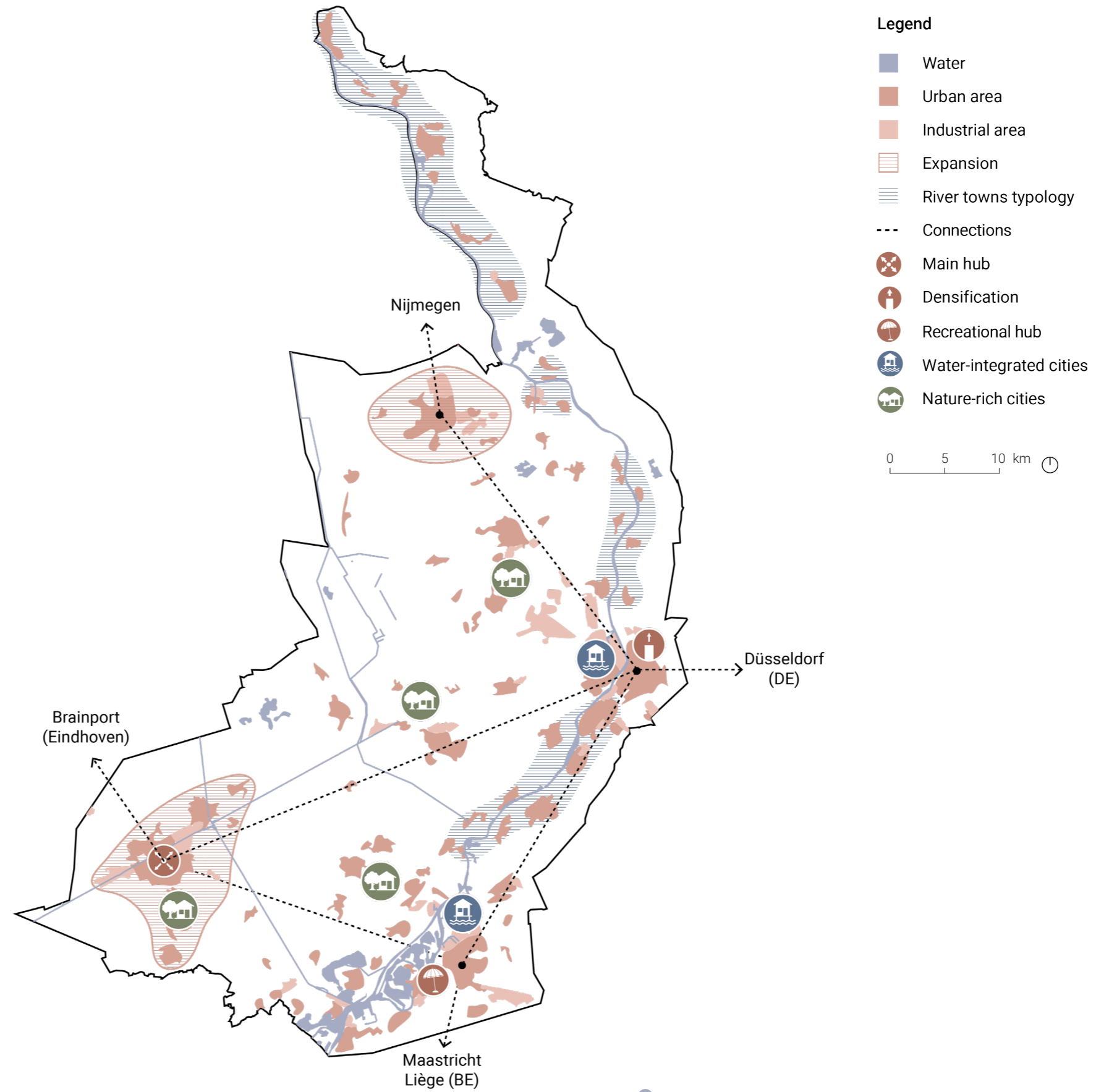


Renaturalised River

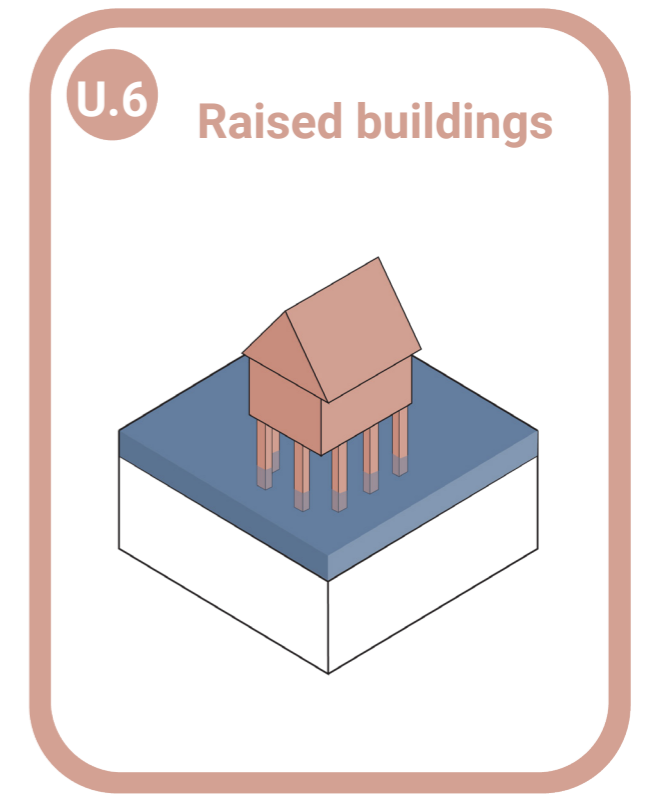
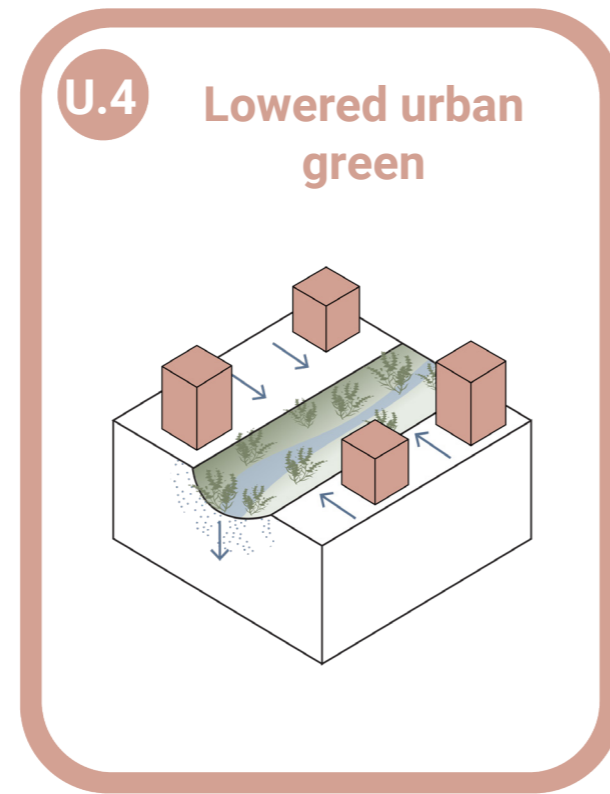
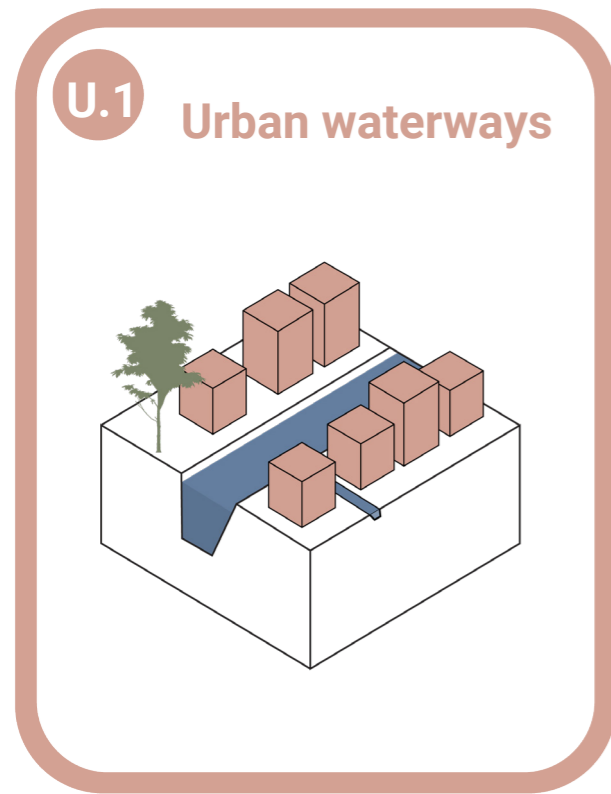
Expanded Ecology

Adaptive Agriculture



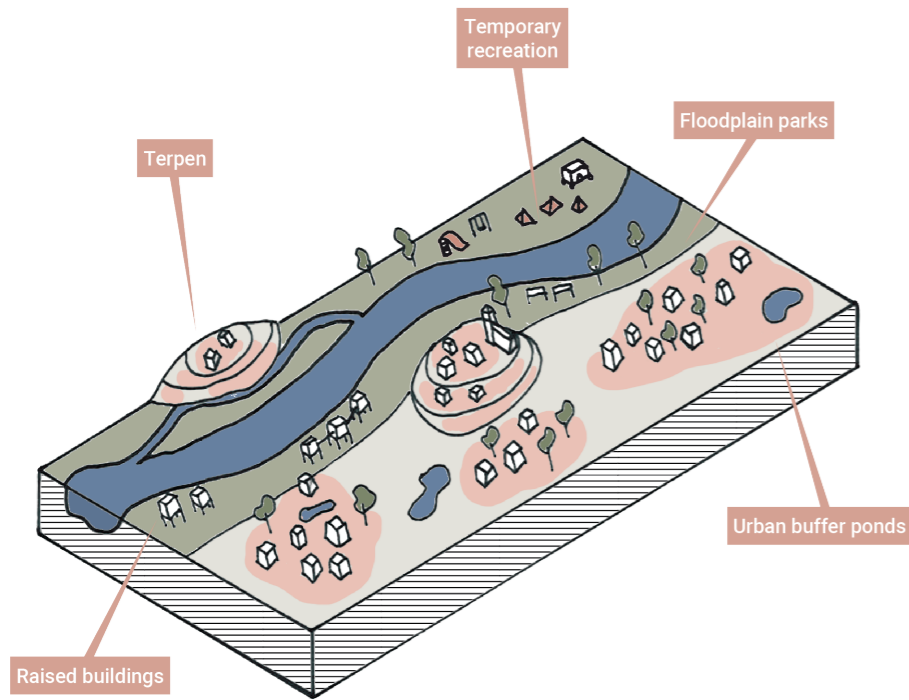


Patterns

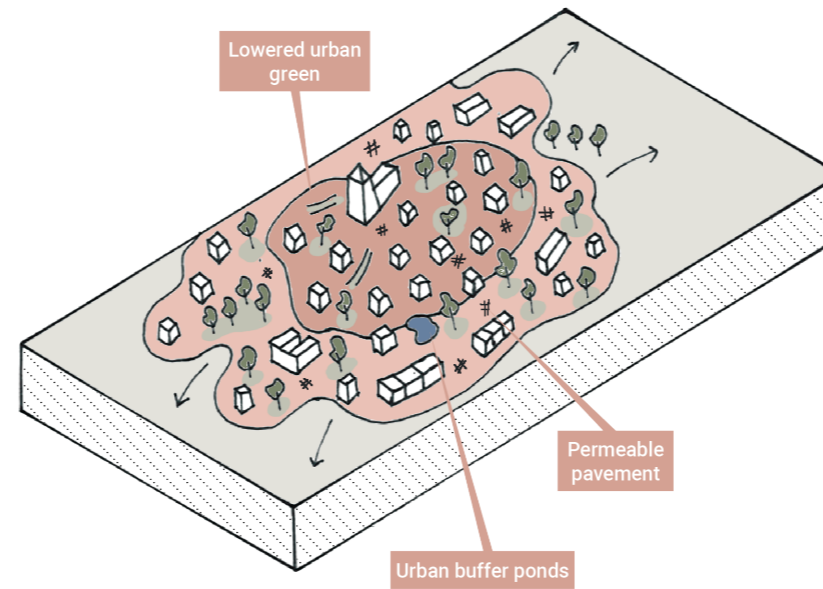


Zoom-ins

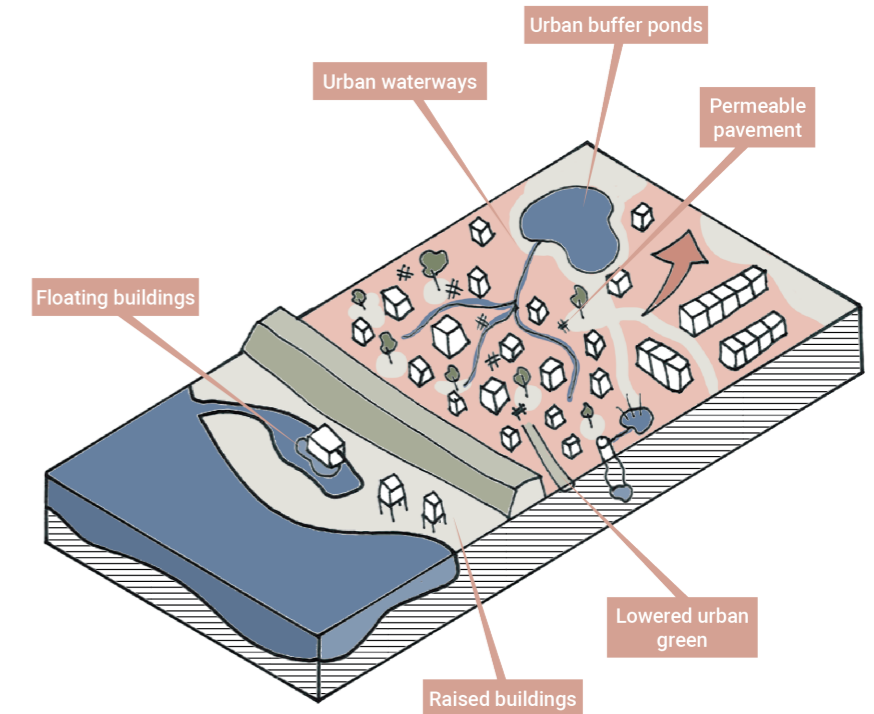
River villages



Dry city



Wet city



Renaturalised River

Expanded Ecology

Adaptive Agriculture

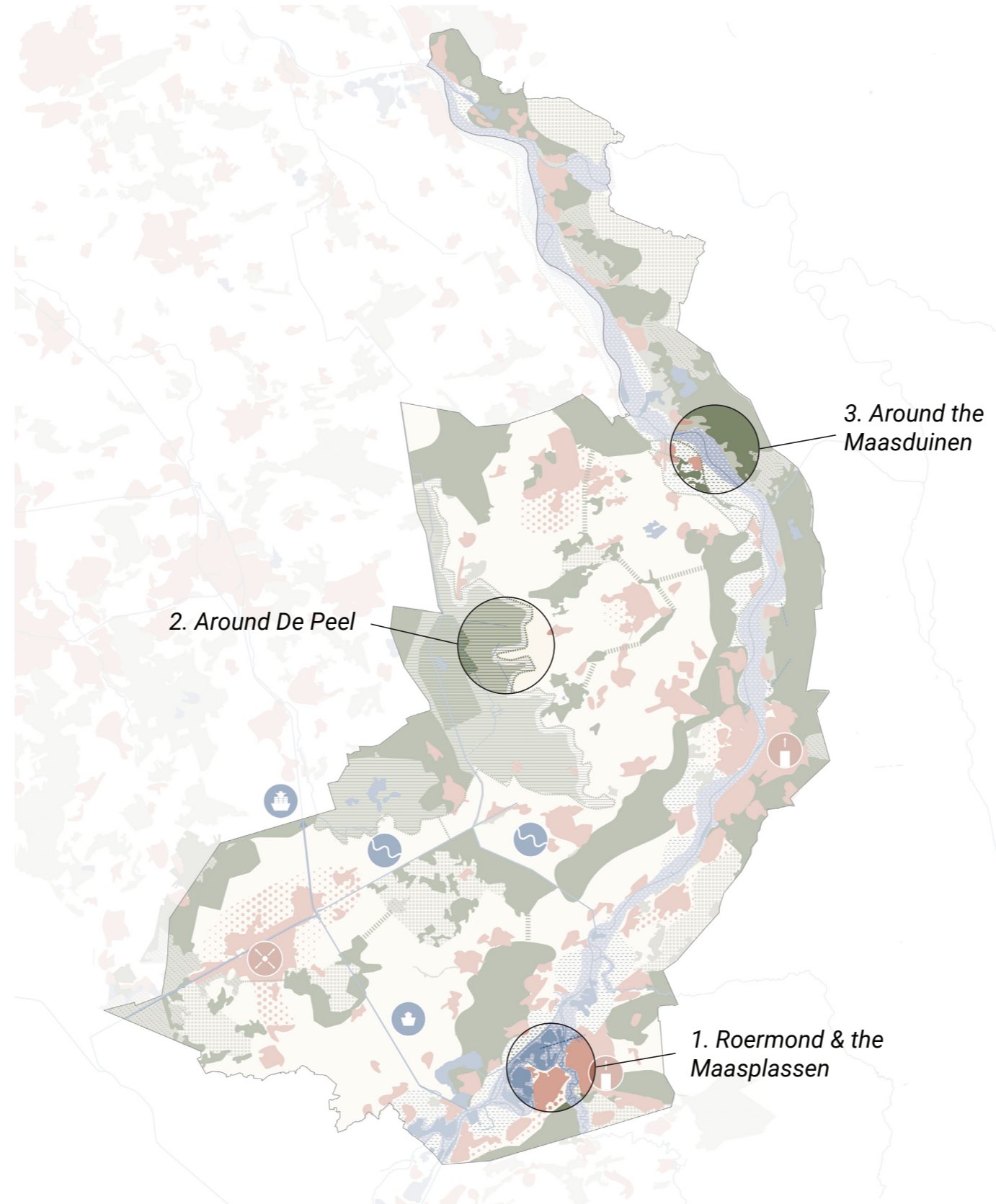
Climate-proof Cities



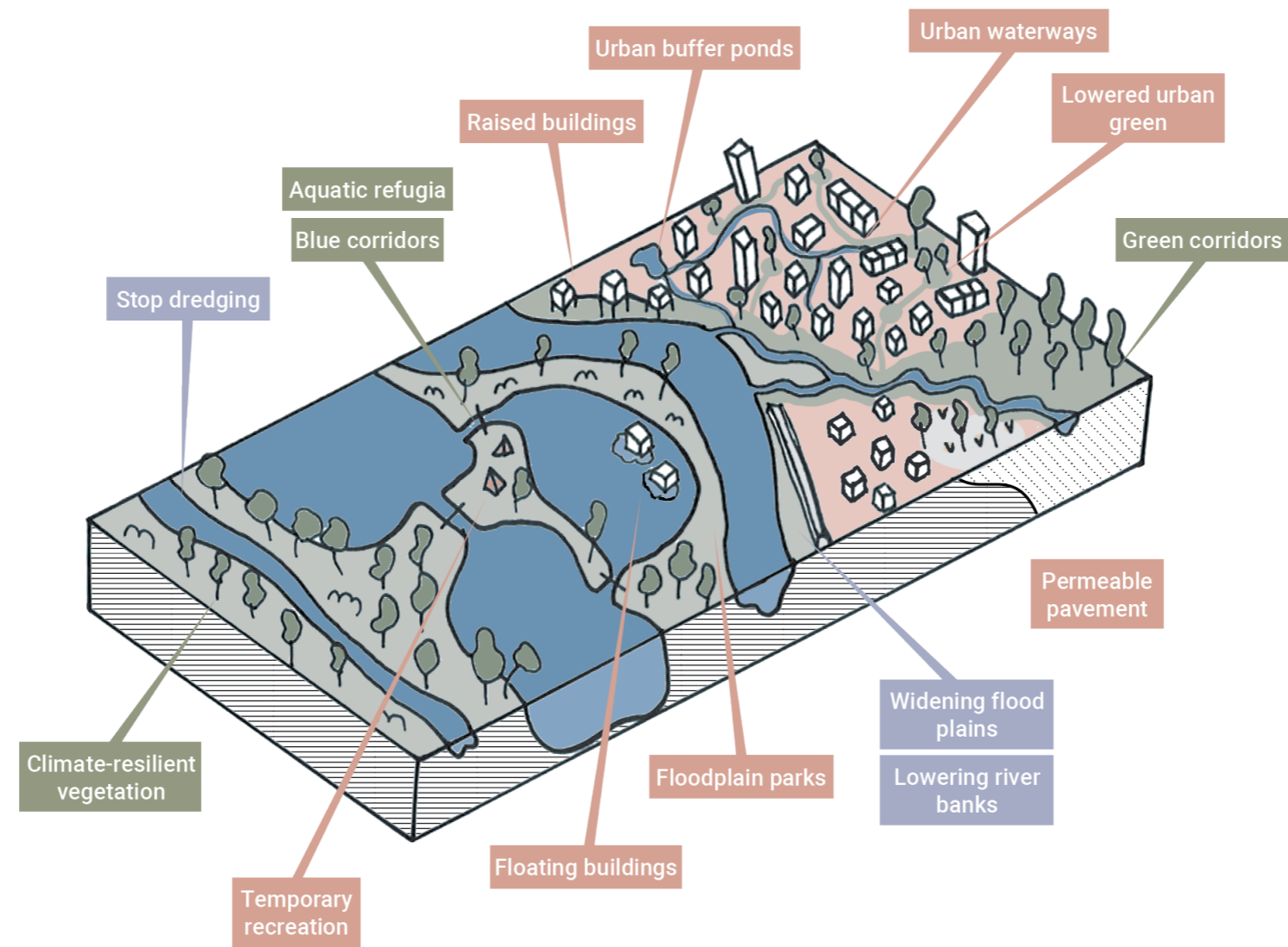
Legend

- Water
- Space for renaturalised river
- Forest
- Heath
- Peat bog
- Fens and wetlands
- Drought-resilient agriculture
- Nature-inclusive agriculture
- Flood-resilient agriculture
- Wet agriculture
- Urban area
- Urban expansion
- Green corridor
- Erosion protection
- Shipping canal
- Renaturalisation
- Densification
- Urban hub

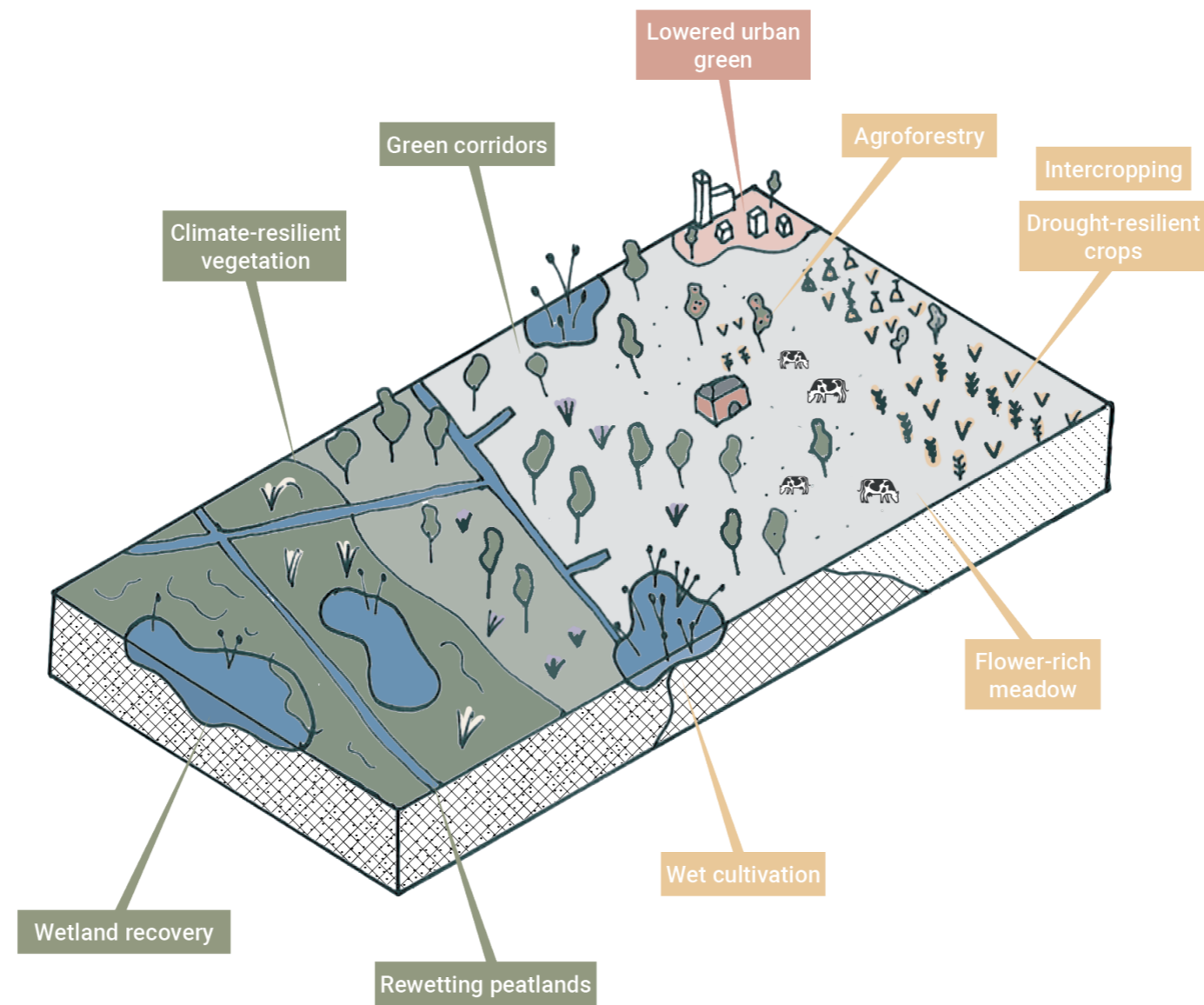
0 5 10 km



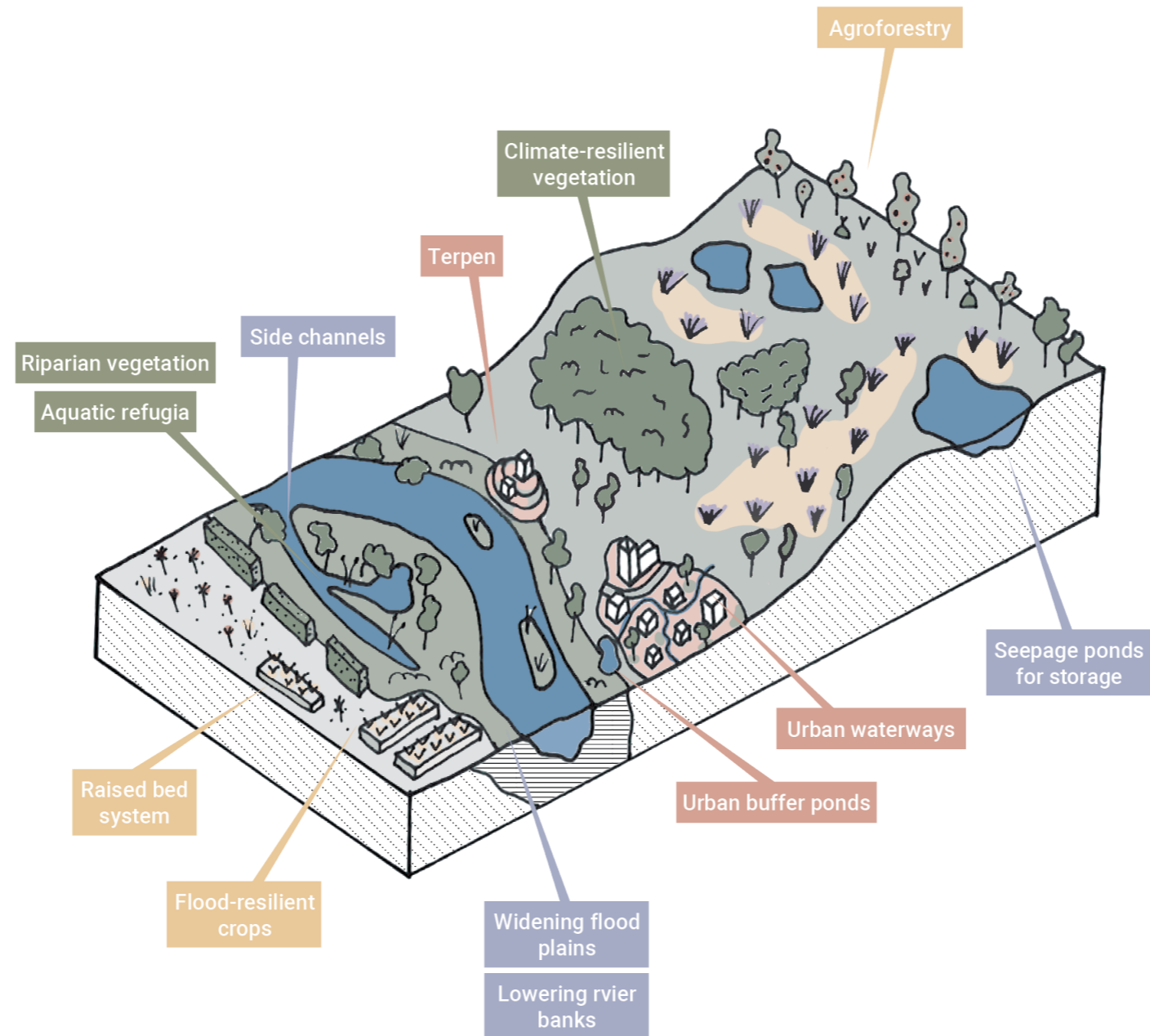
1. Roermond & the Maasplassen



2. Around De Peel



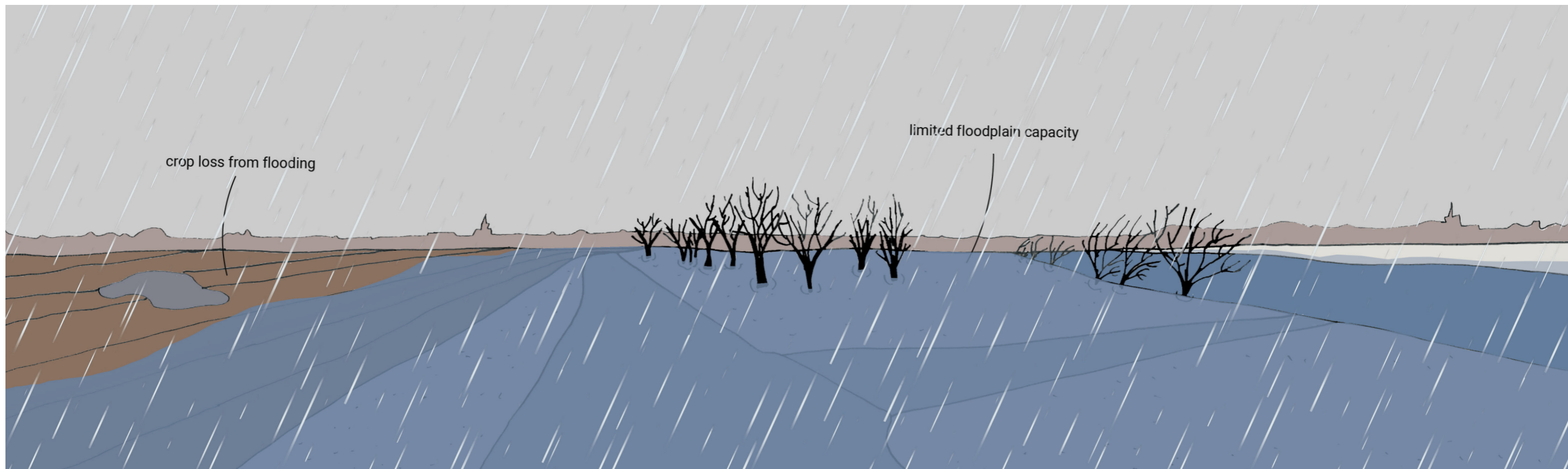
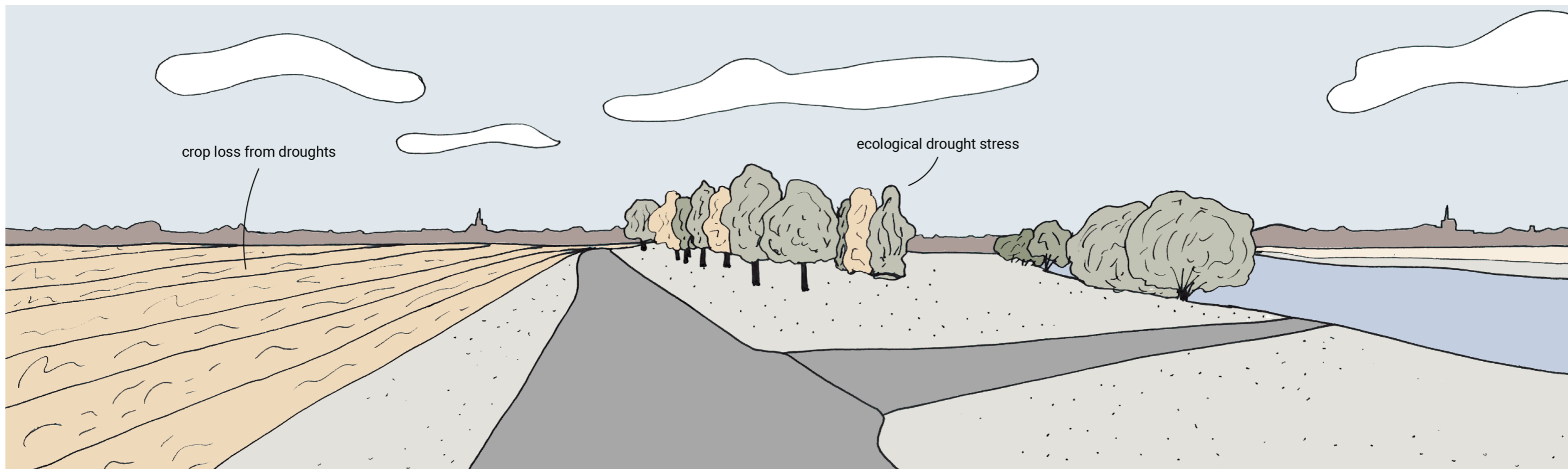
3. Around the Maasduinen



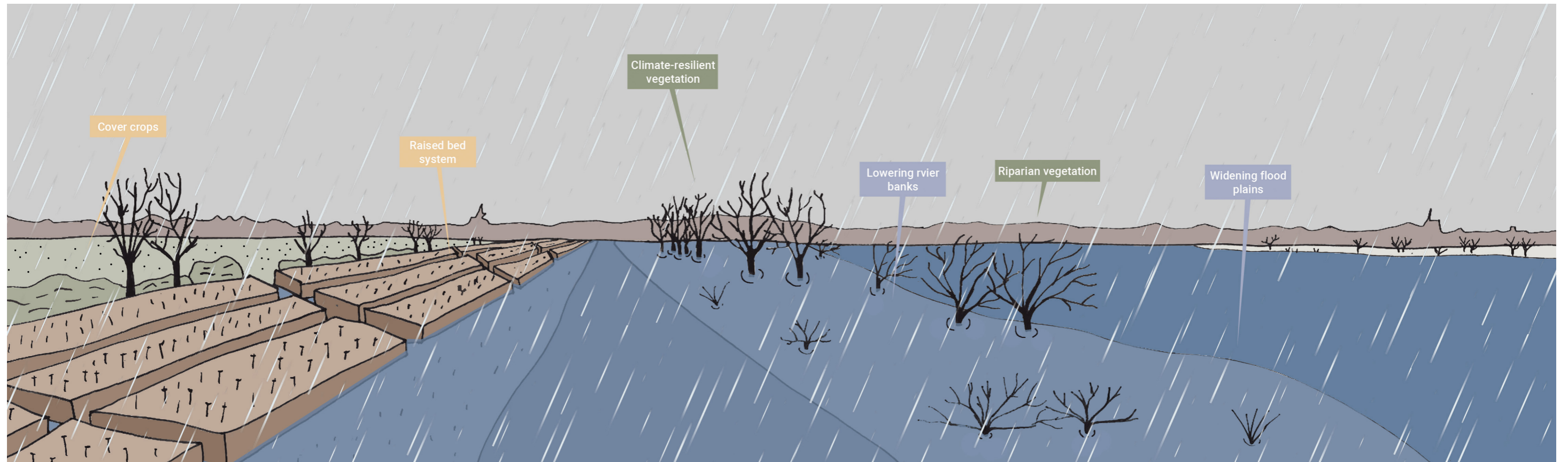
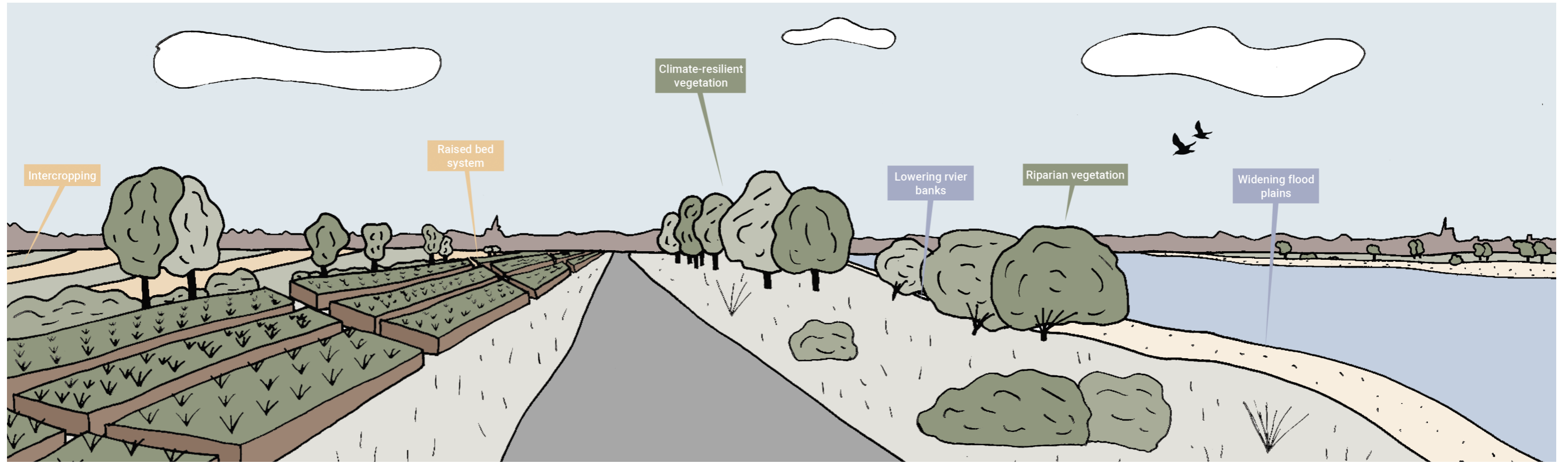
Rural and urban situation



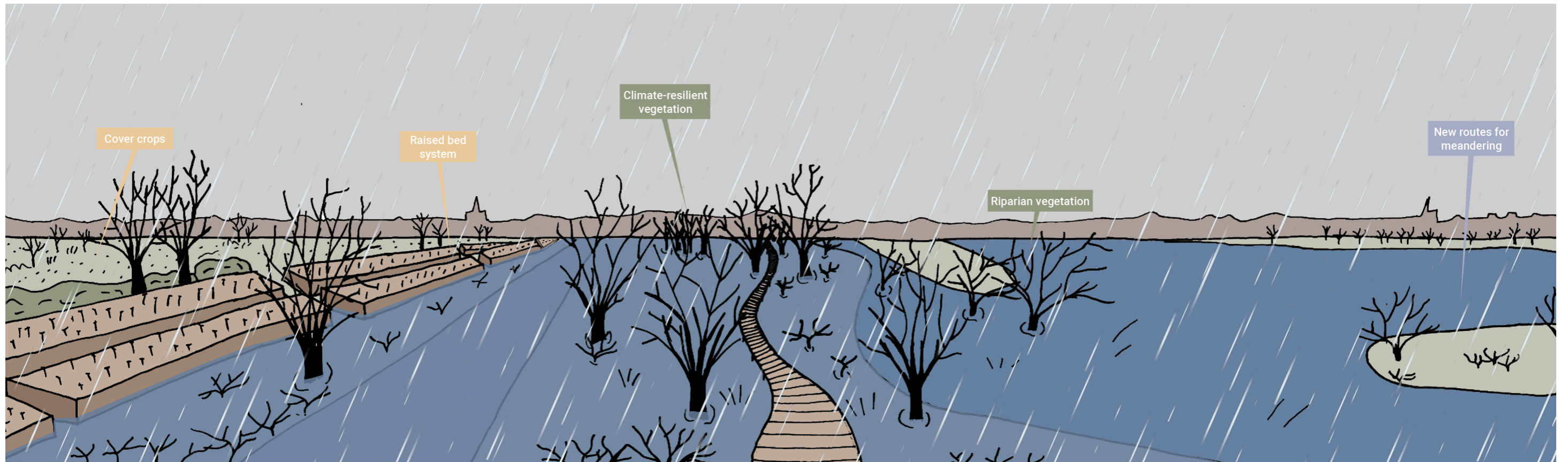
Rural - FAS 2100



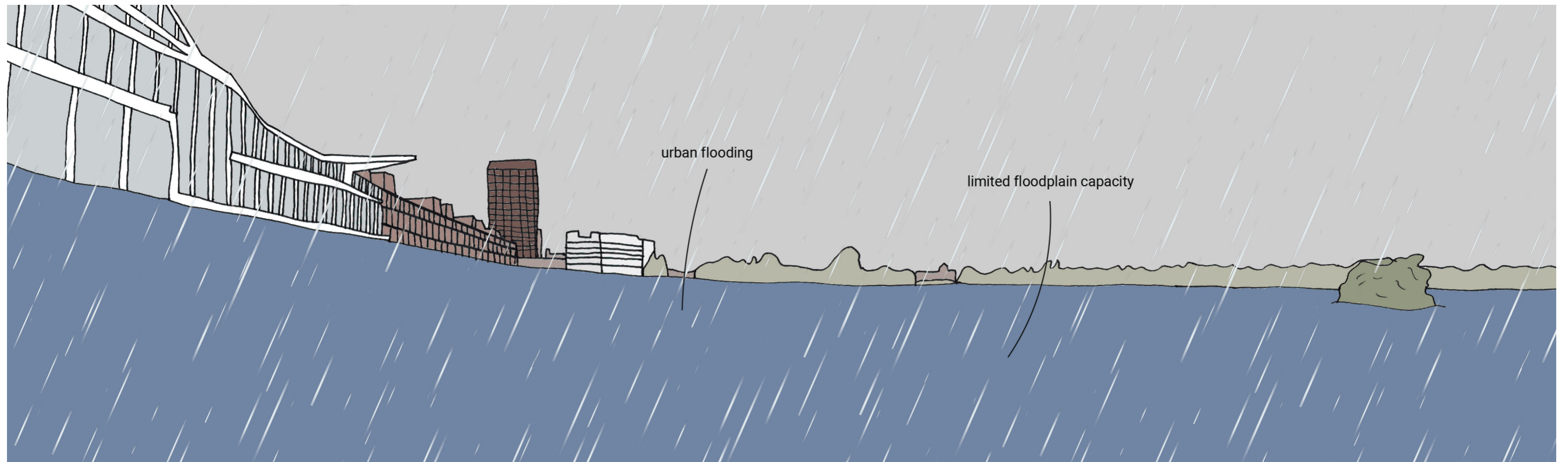
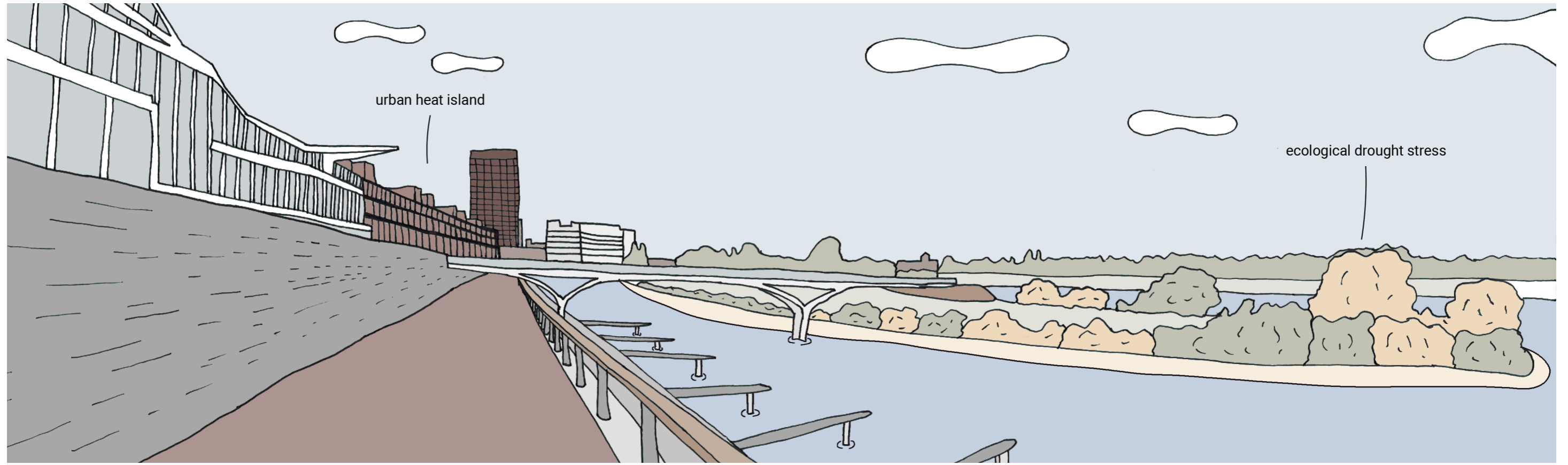
Rural - Design 2050



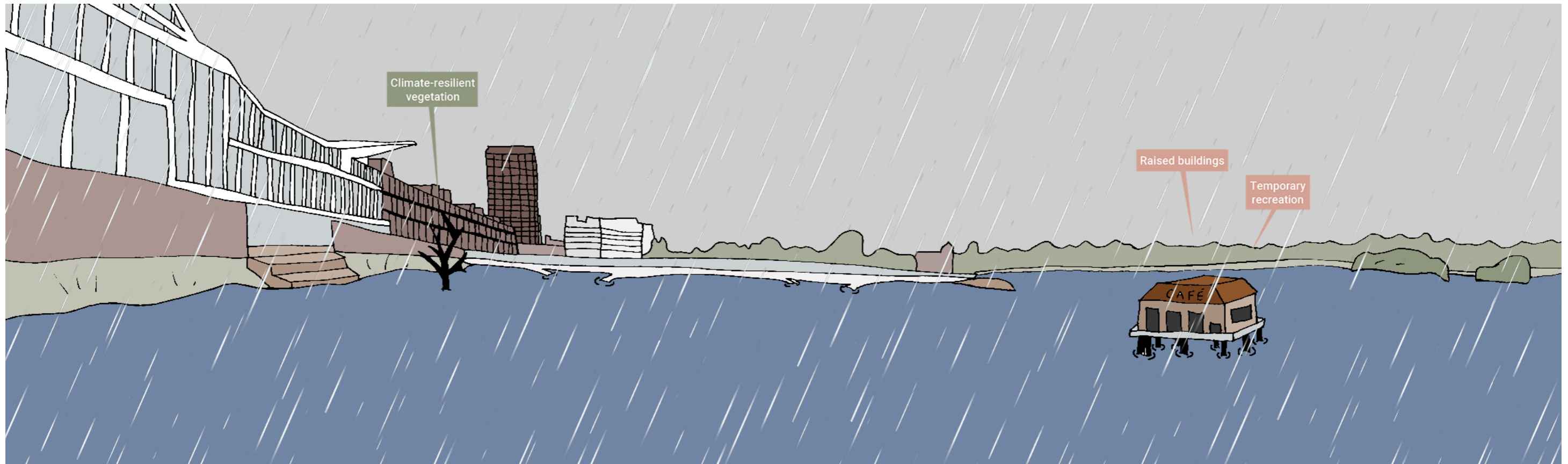
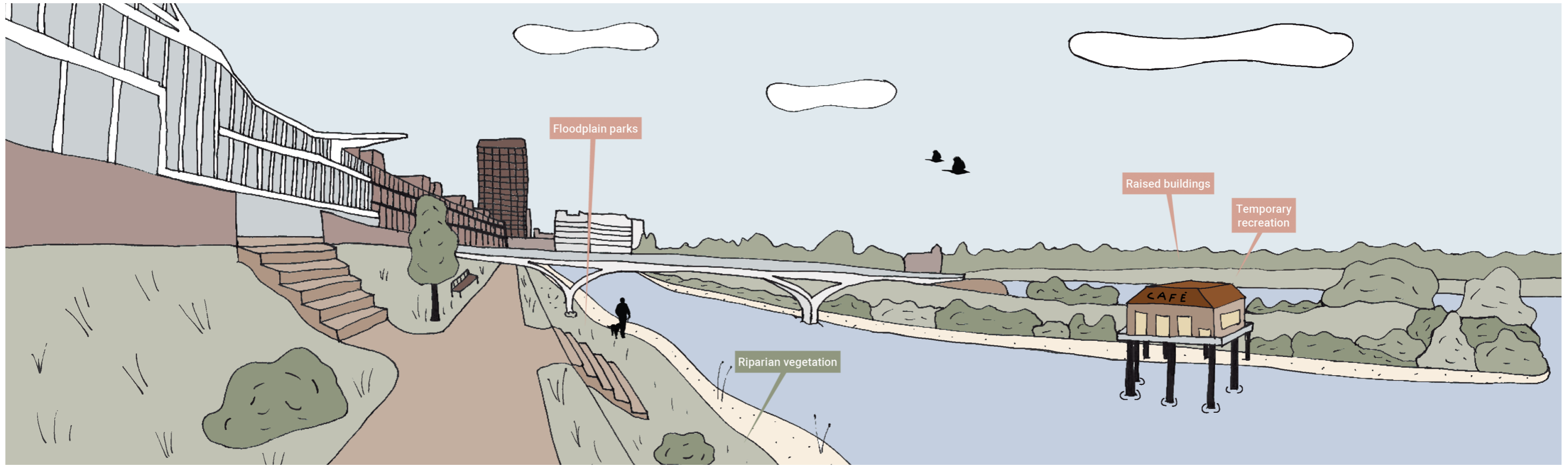
Rural - Design 2100



Urban - FAS 2100



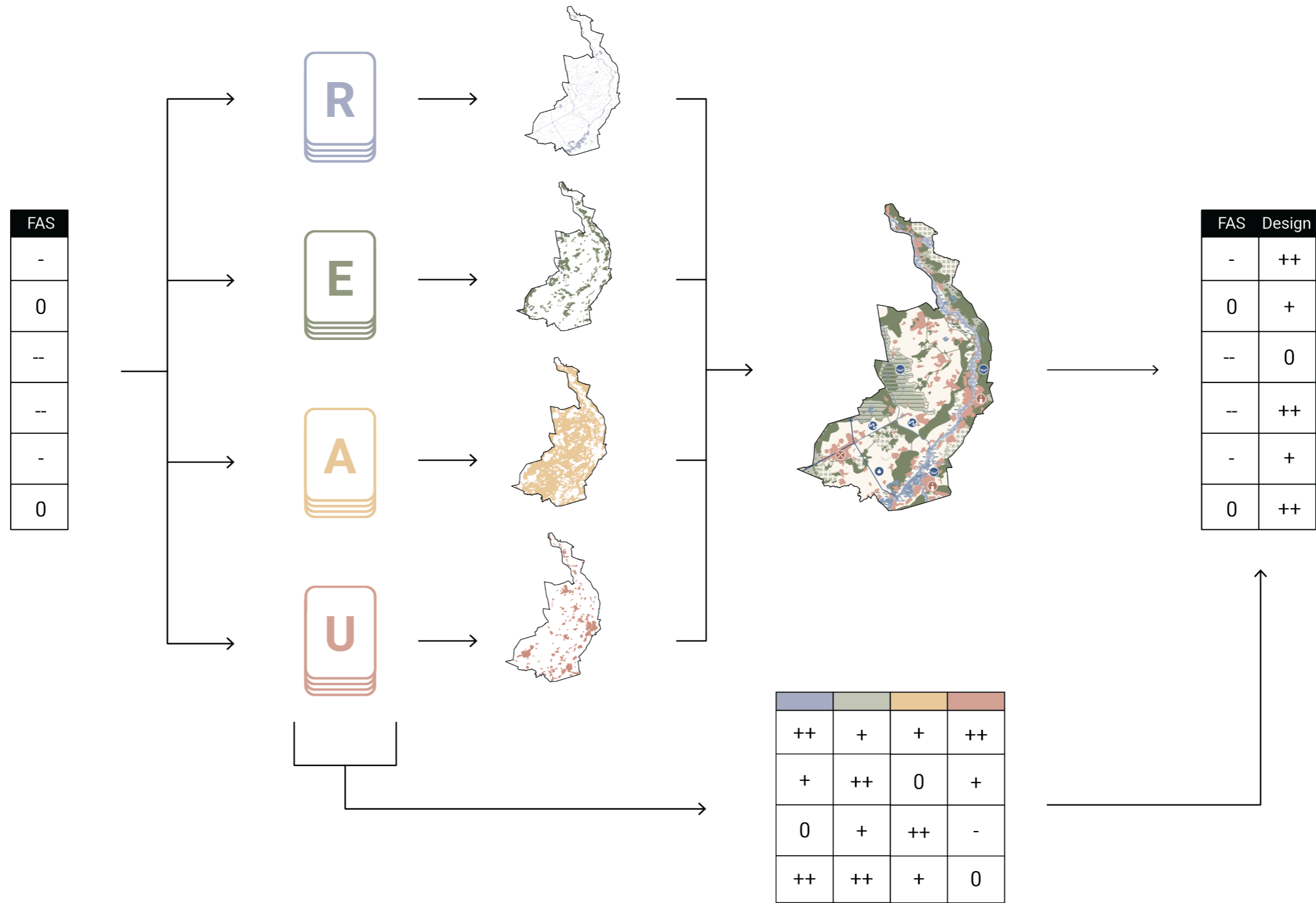
Urban - Design 2050-2100



Conclusion

How will renaturalisation of the river Maas as a climate resilience strategy transform the **Noordelijke Maasvallei** under the most **extreme dry and wet scenarios** by **2100**, and how can the **ecological, agricultural, and urban** landscape evolve with this transformation?

Process



Criteria for a desirable future



Water availability

- Drinking water supply
- Crop water efficiency
- Infiltration and recharge
- Shipping navigability
- Water quality



Water safety

- Urban flood safety
- Crop field drainage
- River space capacity
- Infrastructure resilience



Ecological resilience

- River nature
- Ecosystem connectivity
- Peatland stability
- Nutrient stability
- Heat mitigation



Complementary criteria

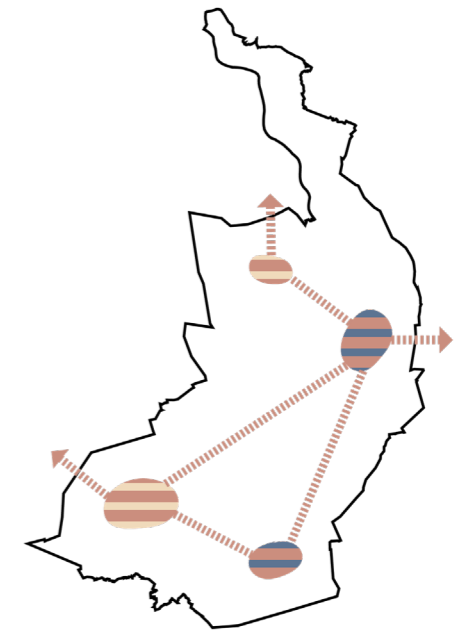
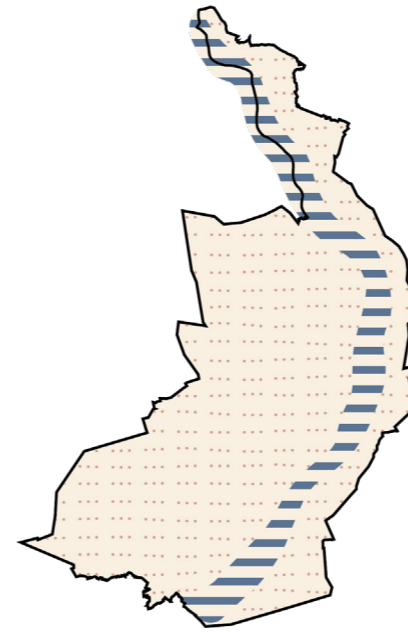
- Water retention
- Natural river dynamics
- Land use compatibility
- Discharge adaptability

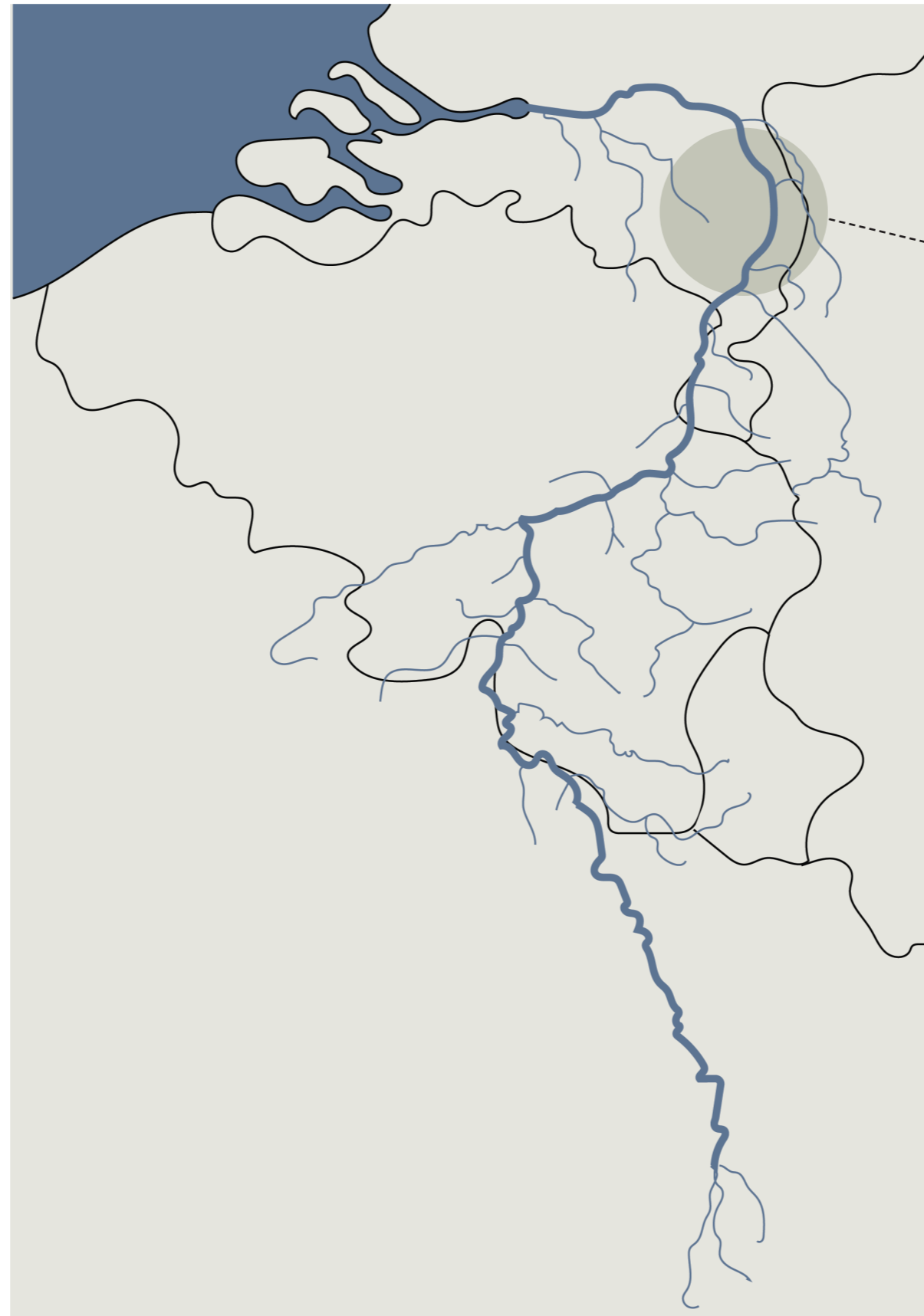
	Criteria	2025	FAS 2100	Design 2100
Water availability	Drinking water supply	+	-	+
	Crop water efficiency	-	--	++
	Infiltration and recharge	-	-	++
	Shipping navigability	+	-	-
	Water quality	0	-	+
Water safety	Urban flood safety	0	-	++
	Crop field drainage	-	--	++
	Infrastructure resilience	+	-	++
Ecological resilience	River nature	--	--	++
	Ecosystem connectivity	-	-	++
	Peatland stability	0	-	0
	Nutrient stability	--	--	++
	Heat mitigation	-	--	+
	Fauna refuge	-	-	++
Complementary criteria	Water retention	0	--	++
	Natural river dynamics	--	--	++
	Land use compatibility	-	-	+
	Discharge adaptability	-	--	++

Effect:

- ++ very positive
- + positive
- 0 no effect
- negative
- very negative

Choices within the maximisation method





Noordelijke Maasvallei

A detailed painting of a river landscape. In the foreground, there are dark green trees on the left and brown, spiky plants at the bottom. A river flows through the center, with a small boat and a reddish-brown sail on the left. The middle ground shows a wide river with a small island or peninsula on the right. In the background, a church spire is visible on a hill under a pale, overcast sky.

Restoring Rivers

Thank you!