Perspectives on the IJssel

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Widening solution space in riverine climate adaptation

Cas C. Goselink - 4463811 - Delft University of Technology - Faculty of Architecture and the Built Environment - Transitional Territories Studio - MSc Urbanism P5 - 16/09/2021

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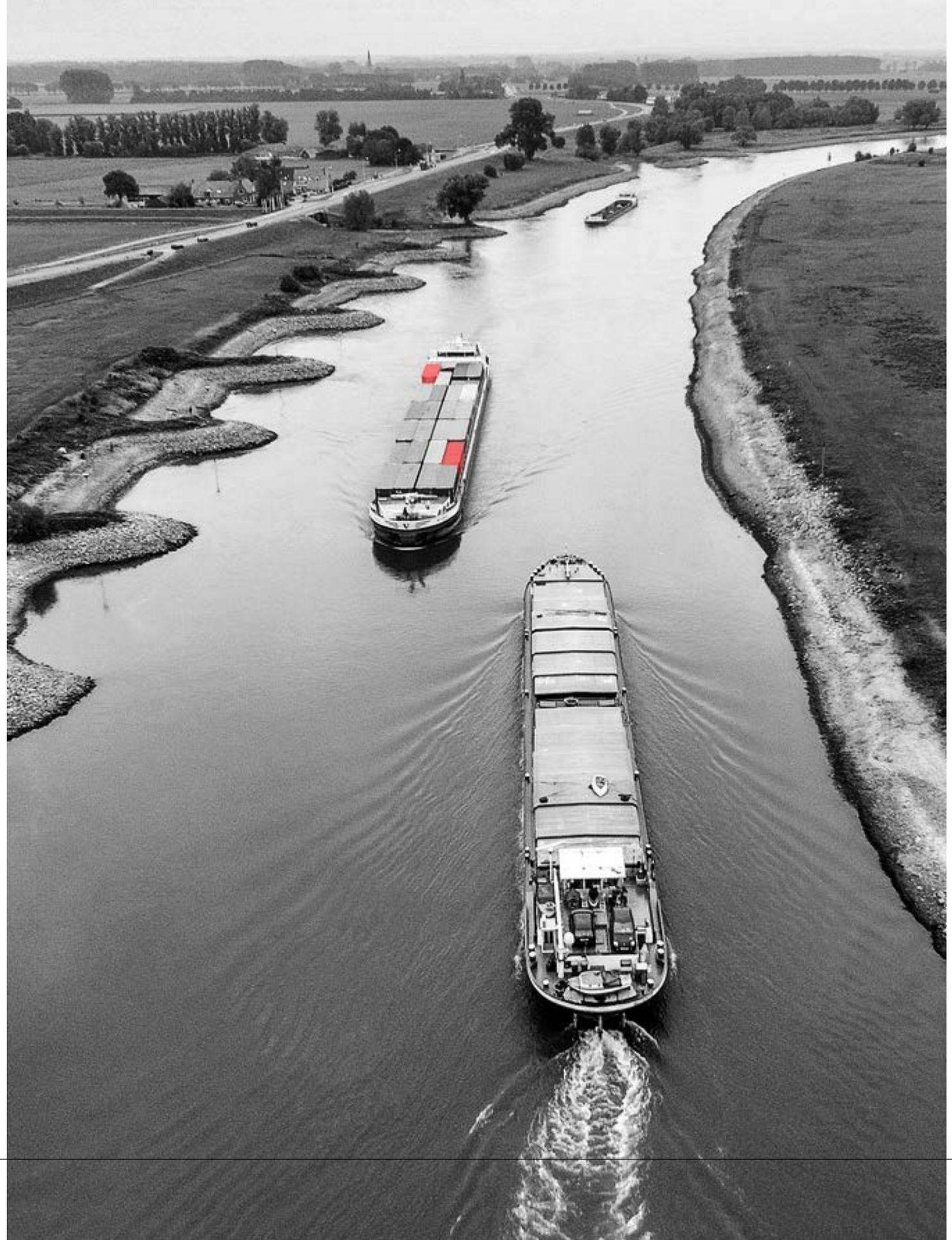
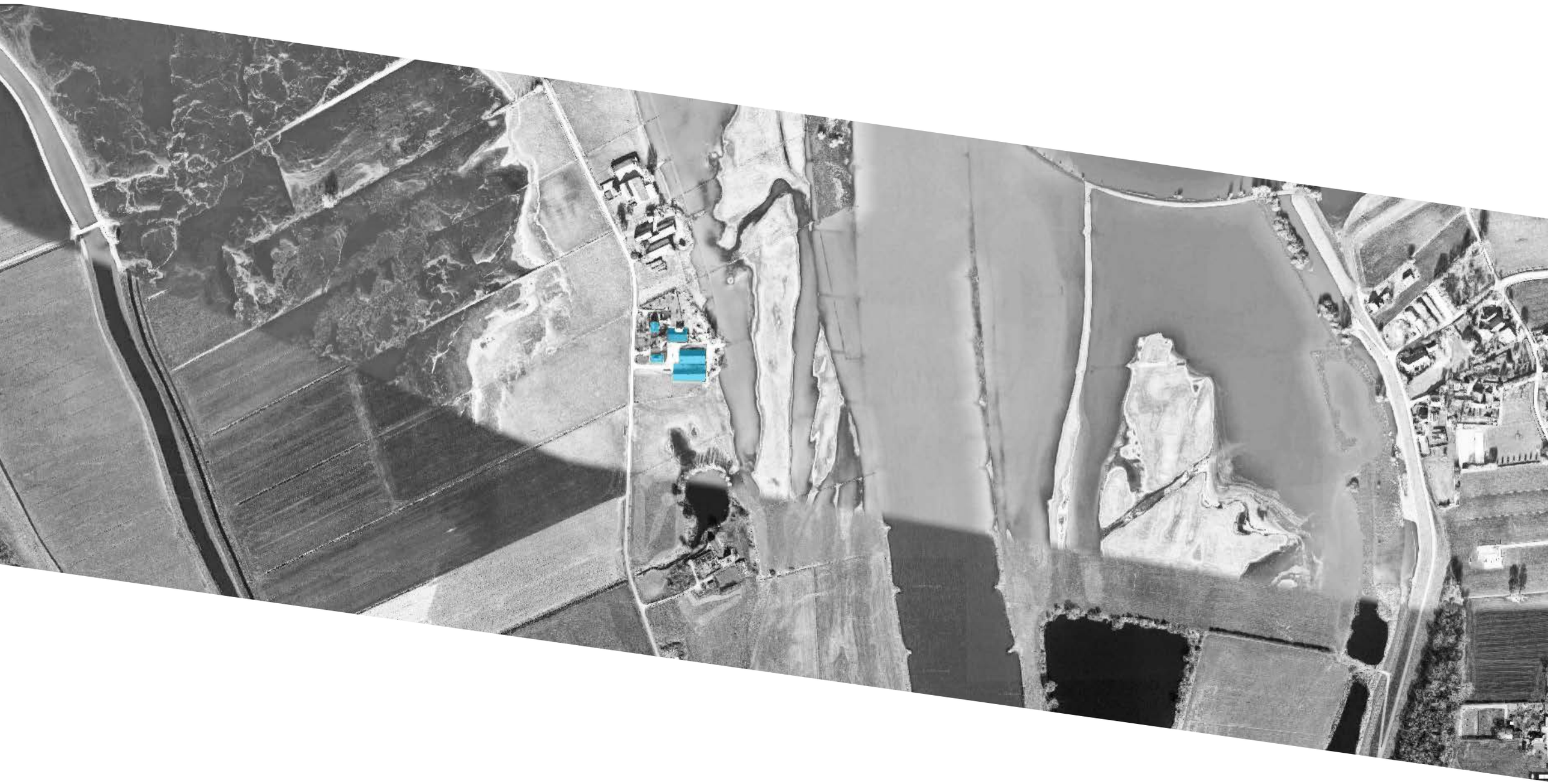
The IJssel during winter, north of Deventer, O.

Figure by Goselink (2021), adapted from: Indebuurt Deventer



The IJssel during summer near Cortenoever, Gld

Figure by Goselink (2021), adapted from: Foto Hissink



Satellite image of the IJssel in both summer and winter near Zwolle, O.

Figure by Goselink (2021), adapted from: Google Maps

Problem Description

Figure 01: News articles related to the new threat of drought, experienced throughout 2018, ‘19 and ‘20.

Figure by Goselink, 2021

The drought of 2018, ‘19 and ‘20 has revealed the fragility of the IJssel in relation to the experienced first notions of a changing hydrological cycle

In order to be able to maintain the intricate riverine systems, adaptation to the new climate regime and hydrological cycle is paramount

The water levels in the rivers will become highly dependent on the amount of precipitation in the catchment basin, and therefore discharge levels will fluctuate increasingly high and sudden

It enhances the need to widen solution space in riverine climate adaptation strategies now

opinie

18 december 2019

De Rijn wordt een regenrivier, tijd voor stuwen en sluizen

Transport In Rijn en Waal zal de waterstand vaker laag zijn. Om Rotterdam bereikbaar te houden is nu actie nodig, schrijven *Peter Lindeboom* en *Henk Kraaijenbrink*.

Wegzakkende IJssel dreigt onbevaarbaar te worden

De IJssel en Waal dreigen in tijden van droogte onbevaarbaar te worden door het almaar verder wegzakken van de rivierbodem. Waar de aandacht lang vooral naar bescherming tegen hoog water ging, moet nu samen met buurlanden en binnenvaart werk gemaakt worden van het waterpeil in de rivier.

Eric Reijnen Rutten 24-01-20, 06:30 Laatste update: 09:05

Reportage

Draaien aan de knop van de nationale regenton

Periodes van droogte zullen vaker voorkomen. Nederland moet zich aanpassen. Aflevering 7 uit een serie: de stuwen, sluizen en kokers bij het IJsselmeer.

Laura Wismans 18 augustus 2020 Leestijd 3 minuten

Opgesloten schippers mogen Deventer haven verlaten

VIDEO **De vijf schippers die 4,5 week geleden door de lage stand van de IJssel vast kwamen te liggen in Deventer, mogen vandaag de haven verlaten. Het eerste schip koos even voor 10.00 uur het ruime sop.**

Yang Yang Chiu 06-09-18, 09:00 Laatste update: 16:59

Societal Relevance

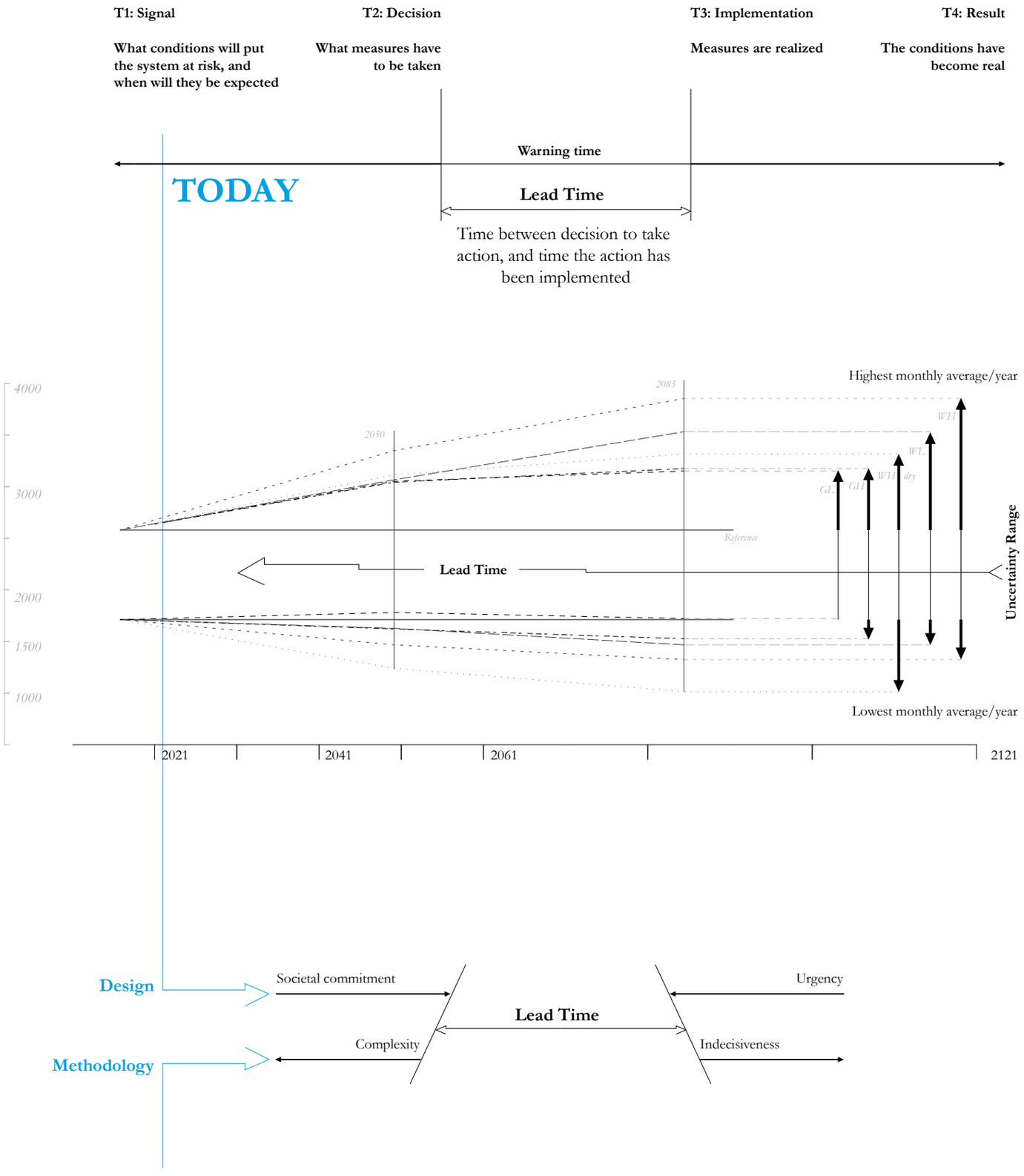


Figure 02: Time horizon of adaptation measures in the planning process

Figure by Goselink, 2021

Design leads to a certain level of tangibility of the large scale and abstract notions of riverine climate adaptation strategies, therefore able to activate a larger audience to join the discussion of possibilities, increasing societal commitment

Methodology based on spatial decomposition aims to reduce complexity of the task ahead by understanding the separate elements within the decomposed interdisciplinary integrative design project

Simultaneously, shortening lead times is not the only aim of widening solution space, but its the planning for the future, in which we do not confine or limit ourselves and our future posibilities through short-term interventions now.

Methodology and Operationalization

Figure 03: Framing of the internal paradox as key to widening solution space through design thinking

Figure by Goselink, 2021

How can the current spatial limitations of riverine territories, caused by the increasingly dynamic shifting hydrological cycle, be mitigated through integrative design?

Three separate subquestions in order to explicitly derive the often implicit creation of a working principle

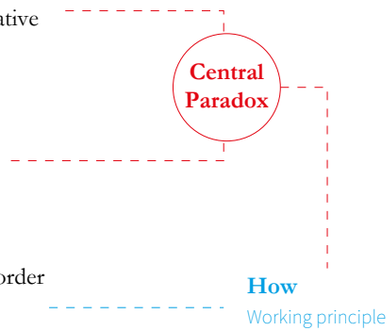
Design experiments to find the objects, services and systems that will work within the working principle to obtain the aspired value

The design experiments show both a detailed understanding of the internal paradoxal relations of the contemporary system, as well as the potentialities from the proposed solution space

How can the current spatial limitations of riverine territories, caused by the increasingly dynamic shifting hydrological cycle, be mitigated through integrative design?

How can the socio-technical regimes adapt to the shifting hydrological cycle through integrative design of the riverine landscape?

How can riverine territories and their socio-technical regimes synthesize, in order to increase performance output to society?



The Conscious Act of Framing

The contemporary riverscape and its riverine regimes

The Anthropogenic Riverscape

Figure 04: Themes relating to the current state of the anthropogenic river

Figure by Goselink, 2021

How can the current spatial limitations of riverine territories, caused by the increasingly dynamic shifting hydrological cycle, be mitigated through integrative design?

Conclusion

Spatial limitations of the riverine territory can be mitigated by applying an integrative design on a high scale level, allowing for deomposing and reconfiguring the system into a complementary set of systems on the lower scale level

Paradoxal proposition

The rigid Dutch anthropogenic riverscape is unable to meet the fluidity demanded by the increasingly dynamic hydrological cycle

Navigation & Drought Management

Figure 05: Systemic functioning of the socio-technical regimes of Navigation and Drought Management

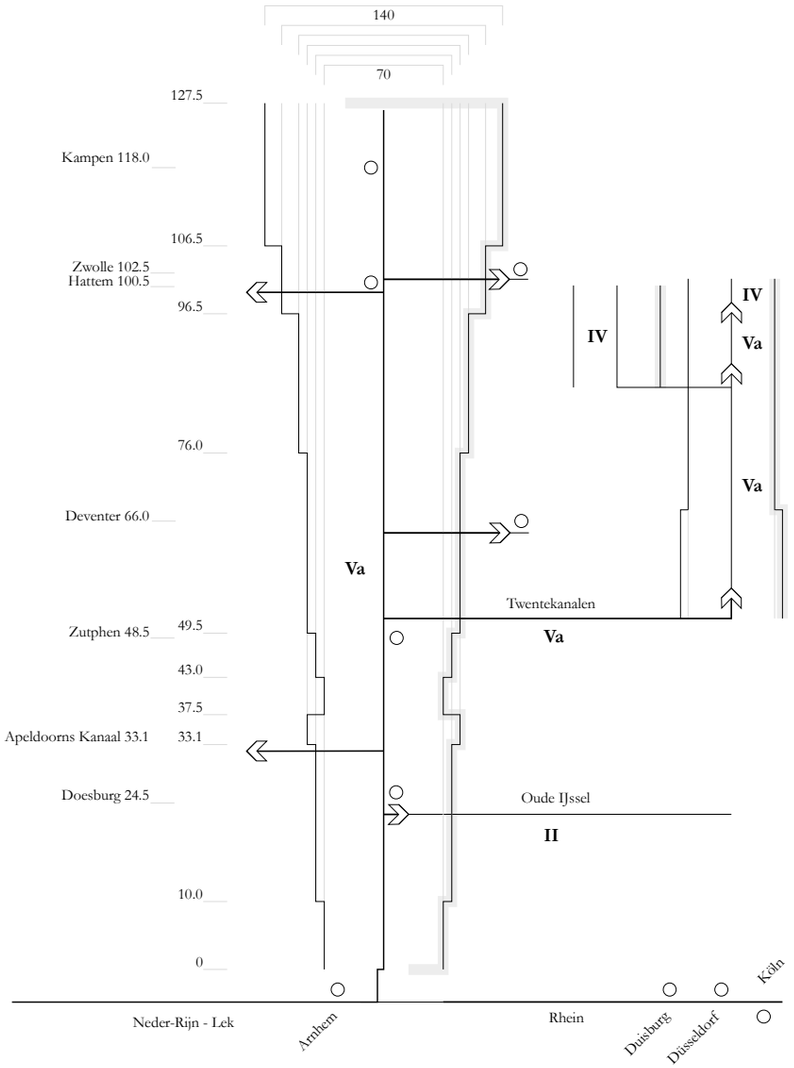
Figure by Goselink, 2021

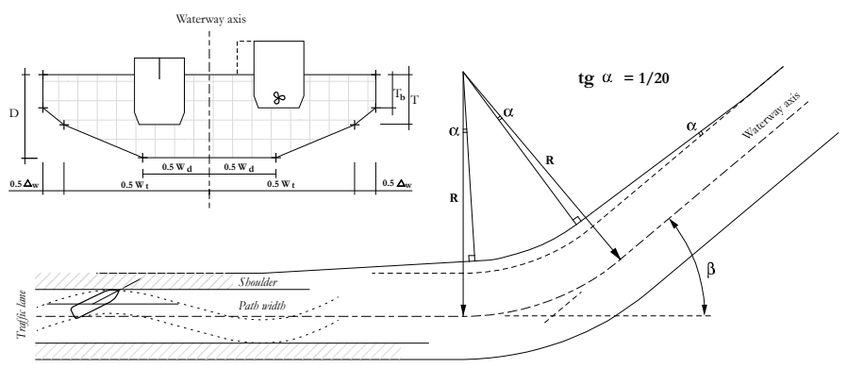
Spatial dependancy on standardized fairway depth and breadth

Necessity and pressure to start planning the compartmentalization of inland waterways with weir- and lock structures, in order to prepare the system for both the modal shift and the shifting hydrological cycle

Vulnerable to hydro-meteorological extremes, highly adapted to the rapid transmission of peak discharges, but unable to mitigate drought

Further compartmentalization of waterways and surface flows to prevent the expedient discharge of water during periods of scarcity, while bifurcation of flows for retention and storage is needed to proactively manage reserves.





Main waterway
Shipping lock complex
Allowed CEMT-class Va
Inland port city
Waterway width 140

High grounds with supply during drought
Fresh water reserve
Supply by pipeline
Salt water intrucion
Throughput for quality standards
Throughput for groundwater replenishment
Weir and lock
Lock
Pumping station

Eco-hydrology & Flood Control

Figure 06: Systemic functioning of the socio-technical regimes of Eco-hydrology and Flood Control

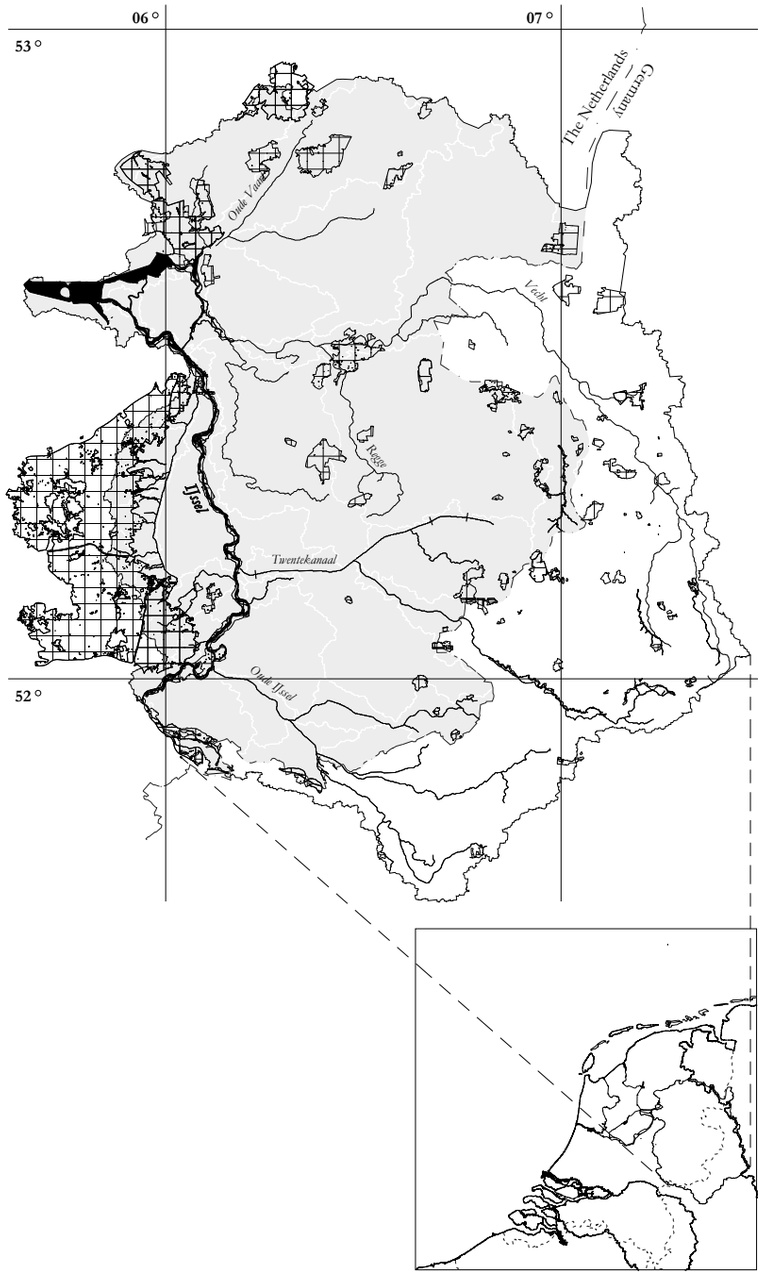
Figure by Goselink, 2021

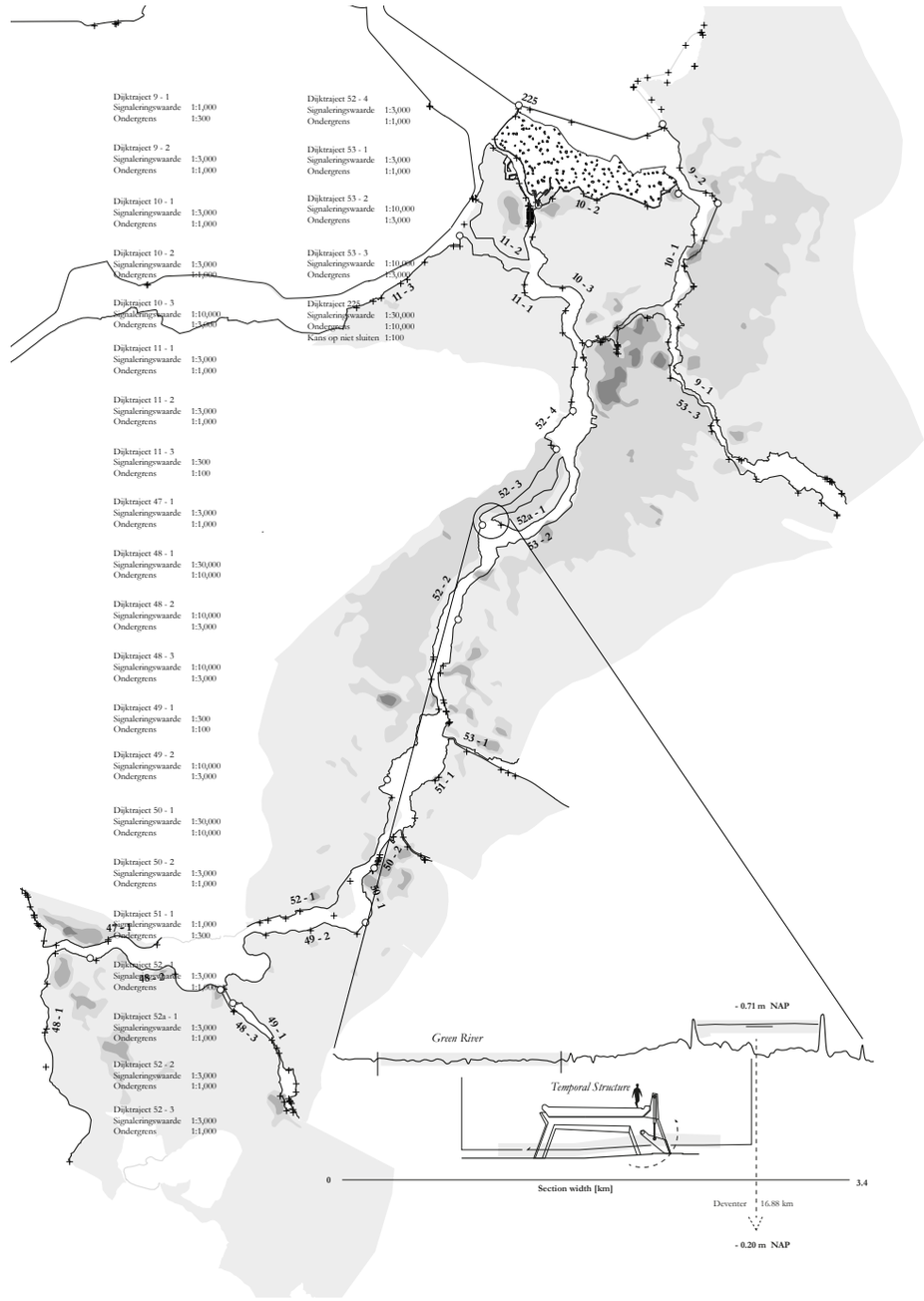
Integrating hydrological and biological components of freshwater ecosystems, based on the ecological functions of flow characteristics in rivers and catchments

Free, variable and uninterrupted flow demanded to connect lateral habitats and longitudinal particle movements

Probabilistic measure of flood hazard, resulting in designed water- and discharge levels which are the basis of the safety structures

Free, uninterrupted flow with a preferred reduction of hydraulic roughness or increasing available space to stay within the designed limits





German IJssel catchment territory
Dutch IJssel catchment territory
Nature reserve
Sub-catchment devide
Waterway

Risk of damage; 10,000+ Eur/ha/yr
Risk of damage; 1,000 - 10,000 Eur/ha/yr
Risk of damage; 100 - 1,000 Eur/ha/yr
Territory in risk of flooding
Dike segment 53 - 1
Segment devide
Flood safety engineering works
Outerdike hedgerows obstructing flow

Socio-technical Regimes

Figure 07: Themes relating to the riverine use and demands

Figure by Goselink, 2021

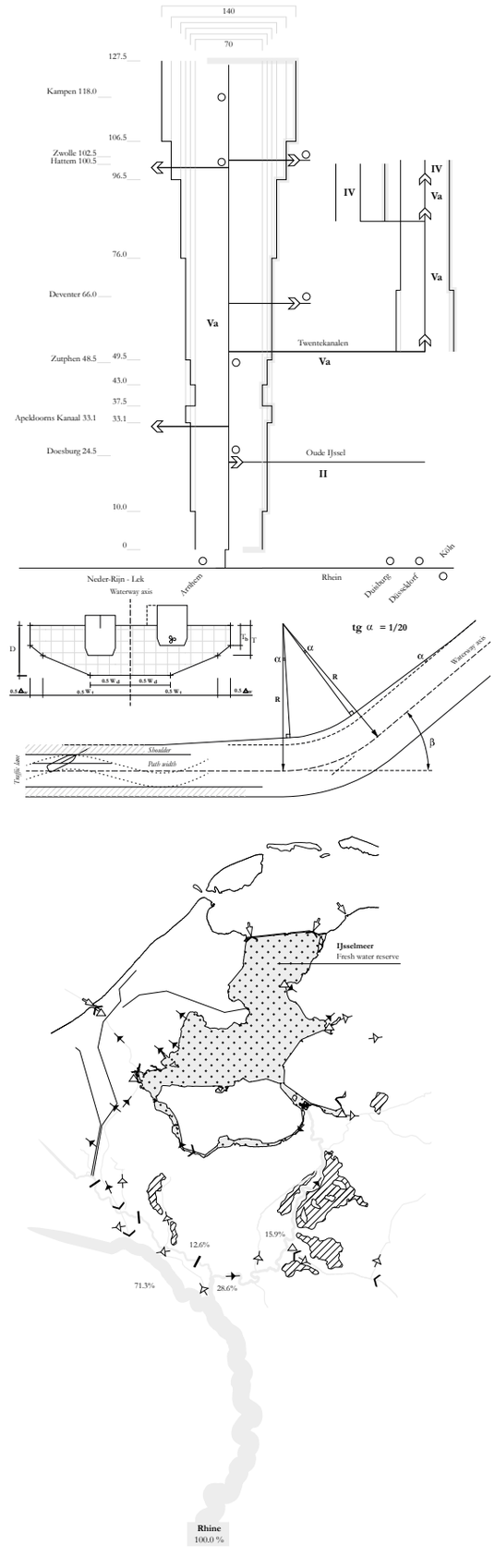
How can the socio-technical regimes adapt to the changing hydrological cycle through integrative design of the riverine landscape?

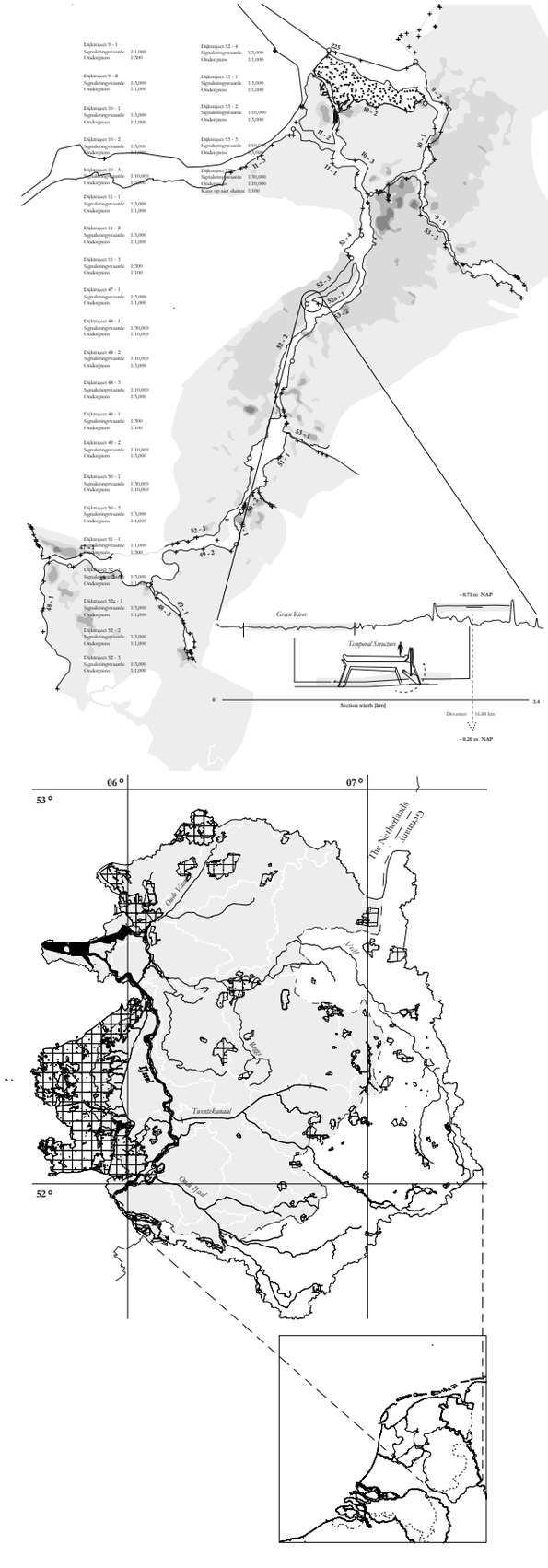
Conclusion

The opposing needs displayed by the regimes aim towards a deeper embeddign into the riverscape, demanding more spatial alteration to fit their needs, resulting in incompatibility of the conflicting territory

Paradoxal proposition

The separate regimes display increasingly opposing needs in relation to flow characteristics; in need of either compartmentalization or uninterrupted flow.





The Formulation of a Key Thesis and Working Principle

Central paradox: increasingly opposing demands for rigidity and fluidity within the conflicted territory

Formulation of the Working Principle

Figure 08: Deriving a working principle from the central paradox

Figure by Goselink, 2021

Key thesis is the viewpoint of the central paradox in relation to the aspired value, leading to the identification of the working principle

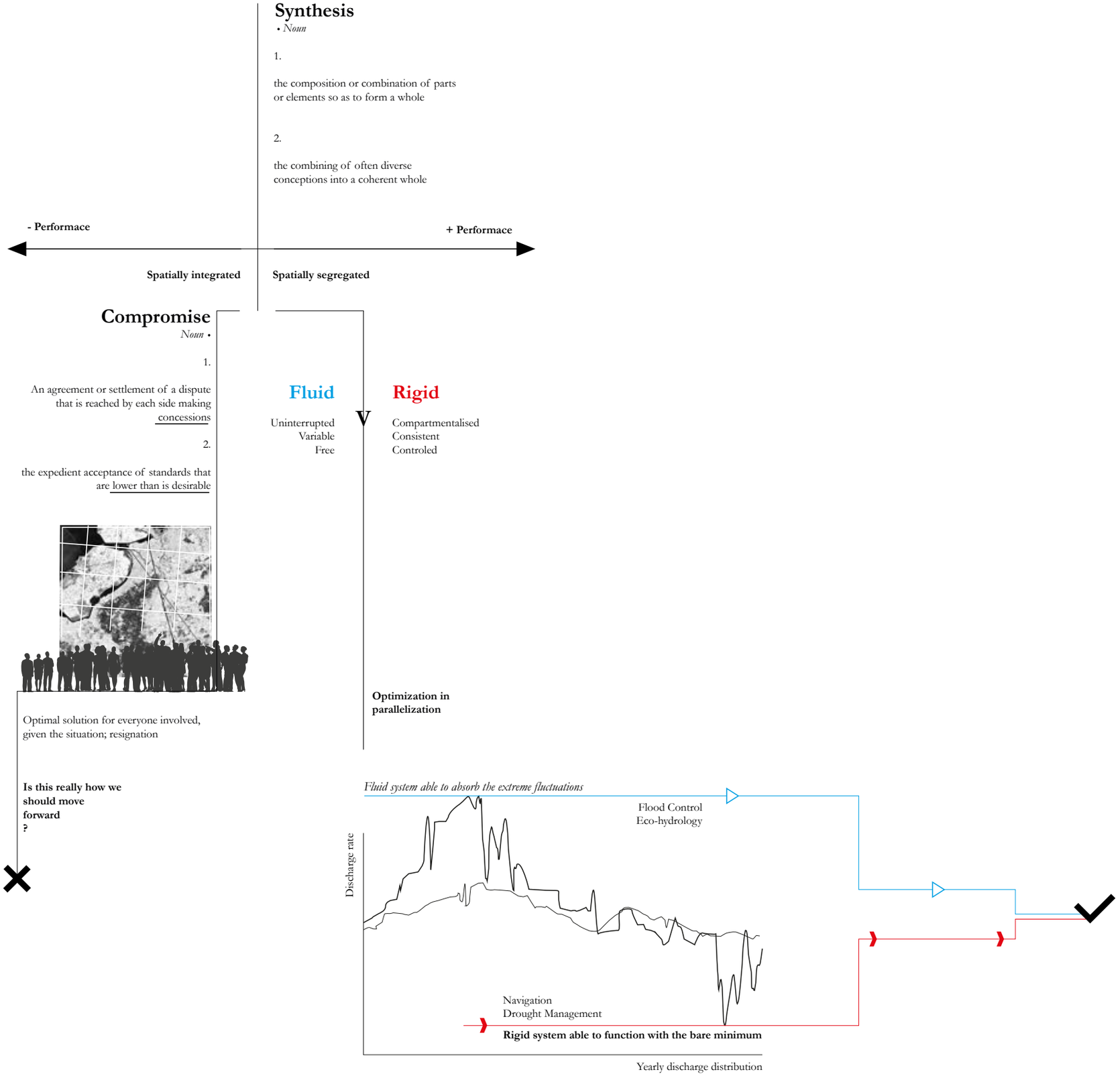
IF we accept that the current river is conflicted between increasingly opposing needs for both rigidity and fluidity,

AND we aspired the value of both adaptation to the shifting hydrological cycle, and the increasing of performance output to society

THEN the riversystem should be optimized in parallelization, providing two complementary services able to synthesize as a whole

How can riverine territories and their socio-technical regimes synthesize, in order to increase performance output to society?

Through spatial segregation of complementary systems, optimization of involved regiems within the reconfigured territory is able to increase performance output to society



Working Principle as Spatial Strategy

Figure 09: Spatial strategy for the IJssel, based on flow characteristics

Figure by Goselink, 2021

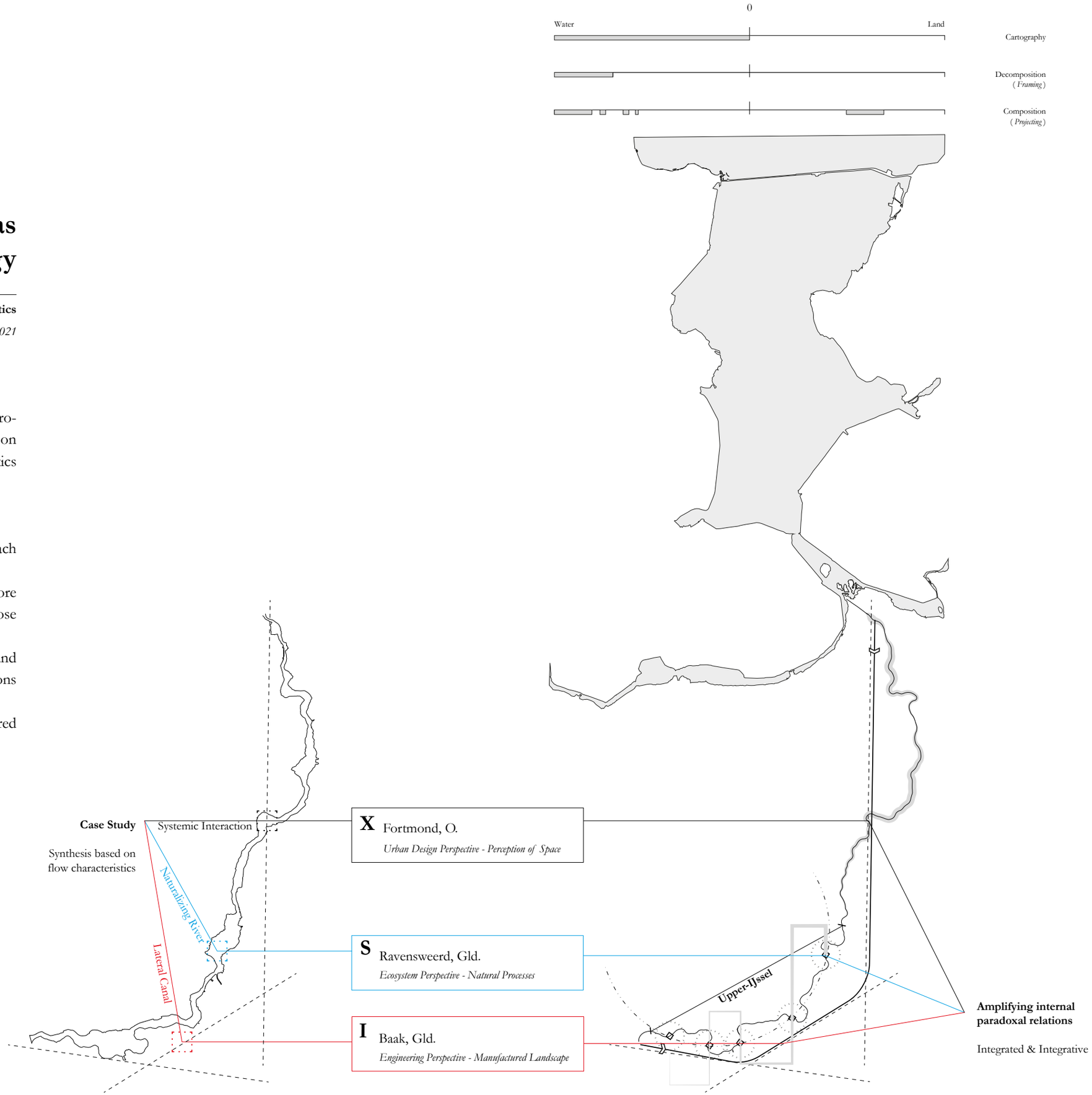
Reconfiguration of the contemporary status quo in order to provide new solution space to be discovered and explored, based on flow characteristics

Threefold functionality of the strategic approach

Understanding of underlying phenomenon of the core paradox, methodological purpose

First designing in separation, then interacting to emphasize and amplify current internal oppositions

Allowing increasing performance output as aspired



Designing in Parallel

Amplifying internal oppositions of rigidity and fluidity

Design Experiment I
Lateral IJssel Canal

Figure 10: Territorial functioning of the lateral IJssel canal

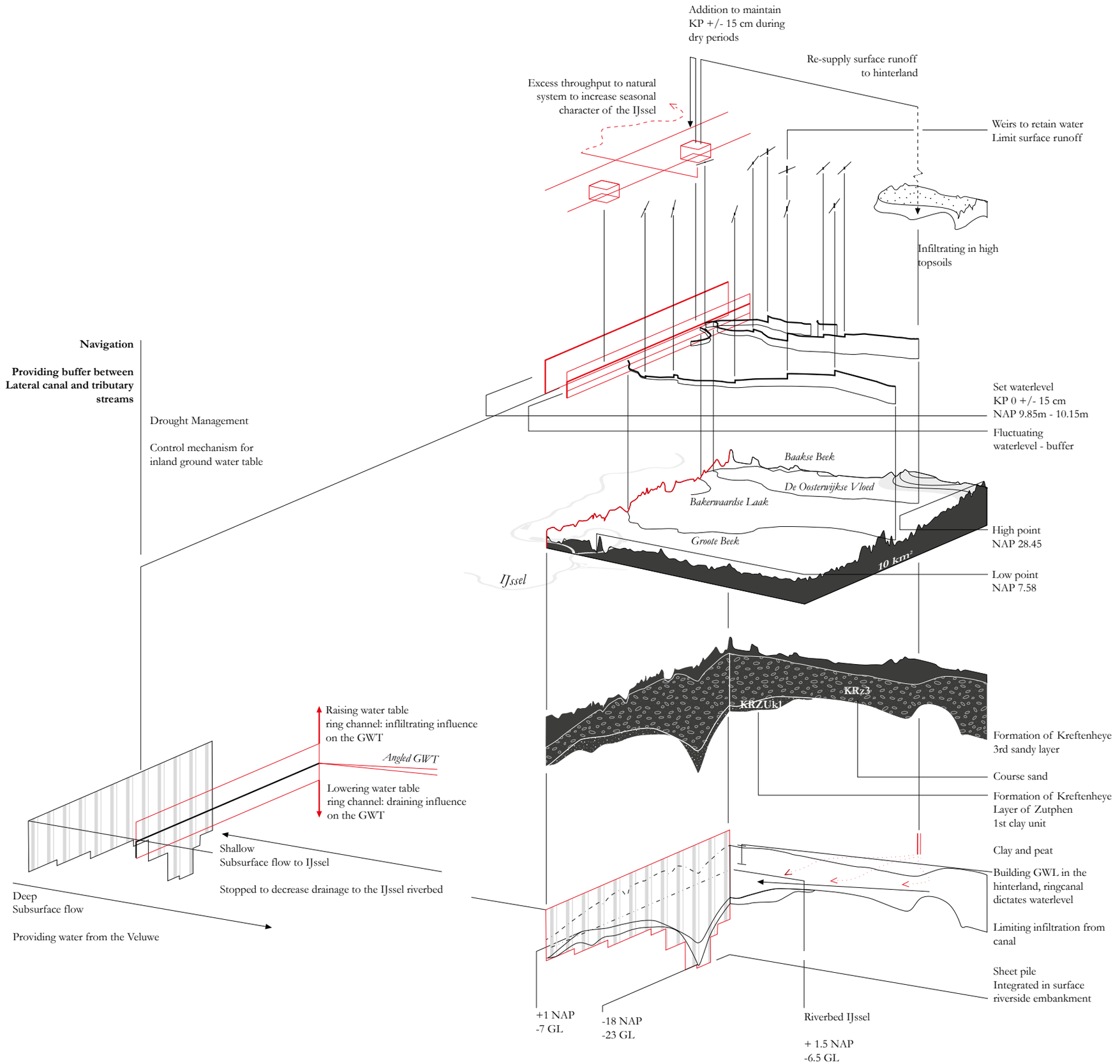
Figure by Goselink, 2021

Extending the demarcation of what is considered to be riverine territory into the hinterland of the IJssel

Proactive interference in natural processes to manage and control available water, in line with the traditional production of landscapes

Secondary buffer channel needed to prevent direct interaction between KP and fluctuating surface water

Sheet piles interfering in shallow subsurface draining capacity of the IJssel towards the east, allowing the canal to become the infiltrating or draining force on the regional GWT



Design Experiment I
Lateral IJssel Canal

Figure 11: Detailed spatial restrictions of the lateral IJssel canal

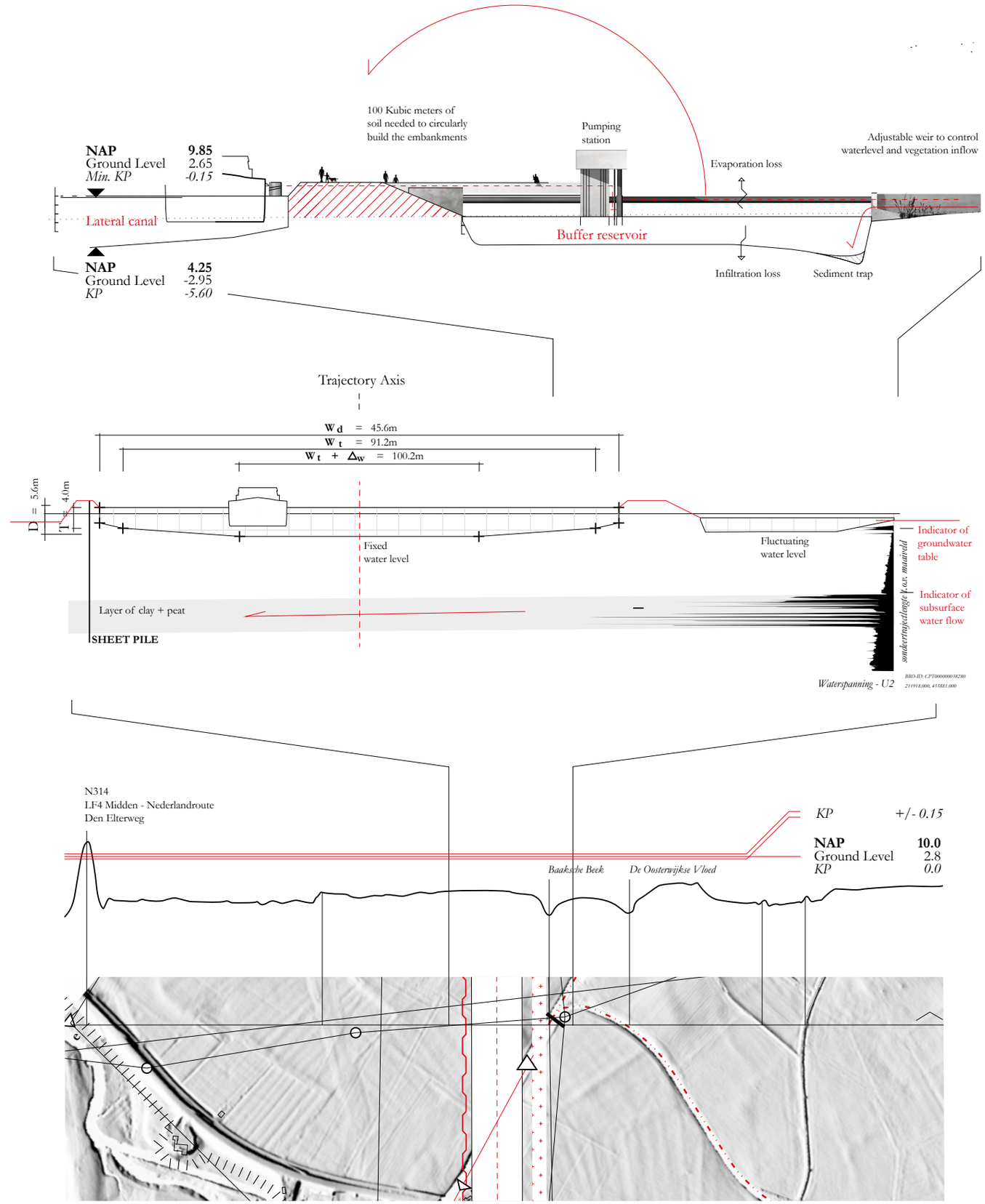
Figure by Goselink, 2021

Navigation dictates precise and extremely stringent spatial restrictions

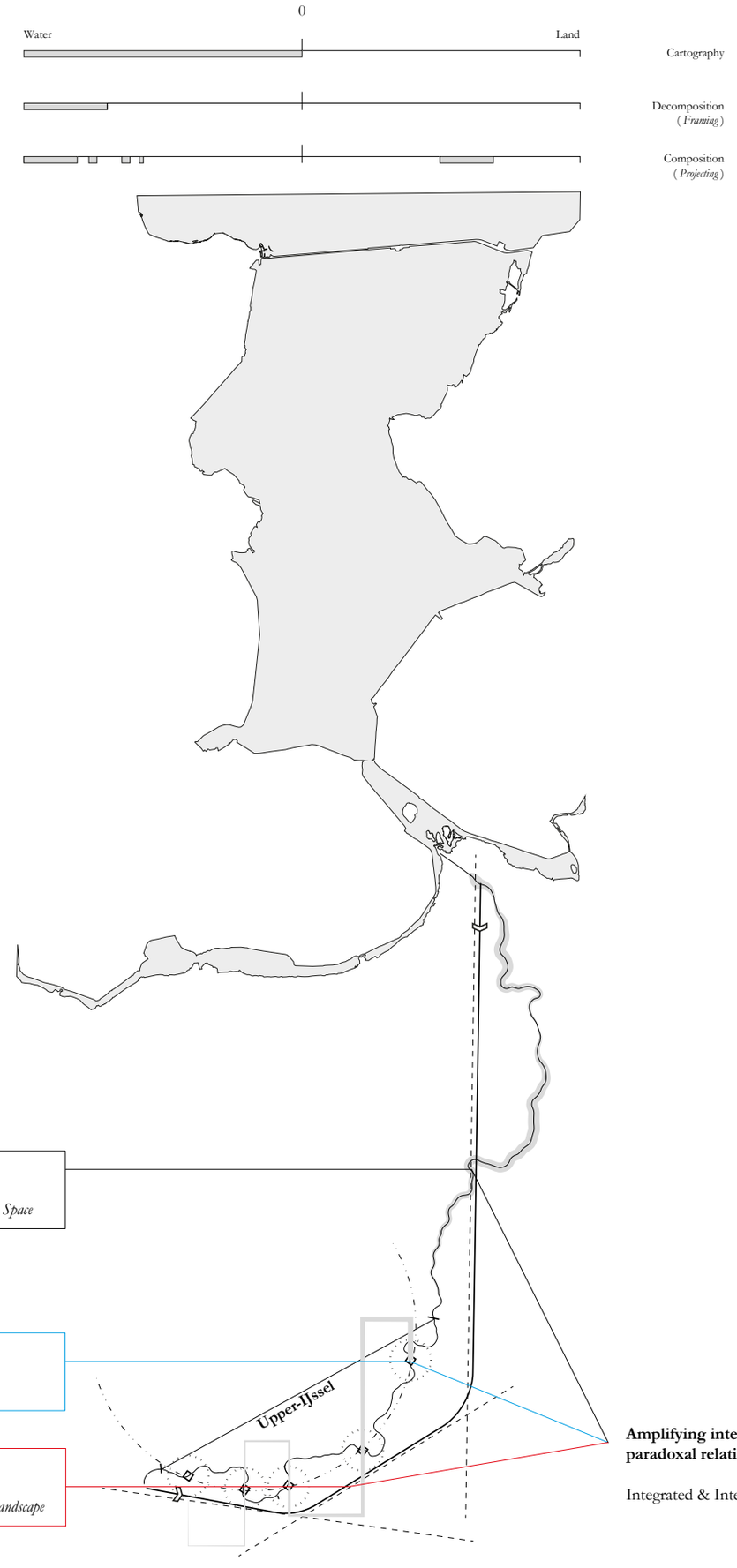
KP derived from close proximity to crossing of the Twentekanalen near Almen (Gld.)

Secondary channel used as sediment trap, lateral buffer to tributaries, longitudinal buffer through the region, and for circular local soil use

Extremely stringent spatial demands, invasive to the territory in both form (linear) and functioning (proactive interference and redistribution of assets)



Working Principle as Spatial Strategy



Design Experiment S
Renaturalizing Riverscape

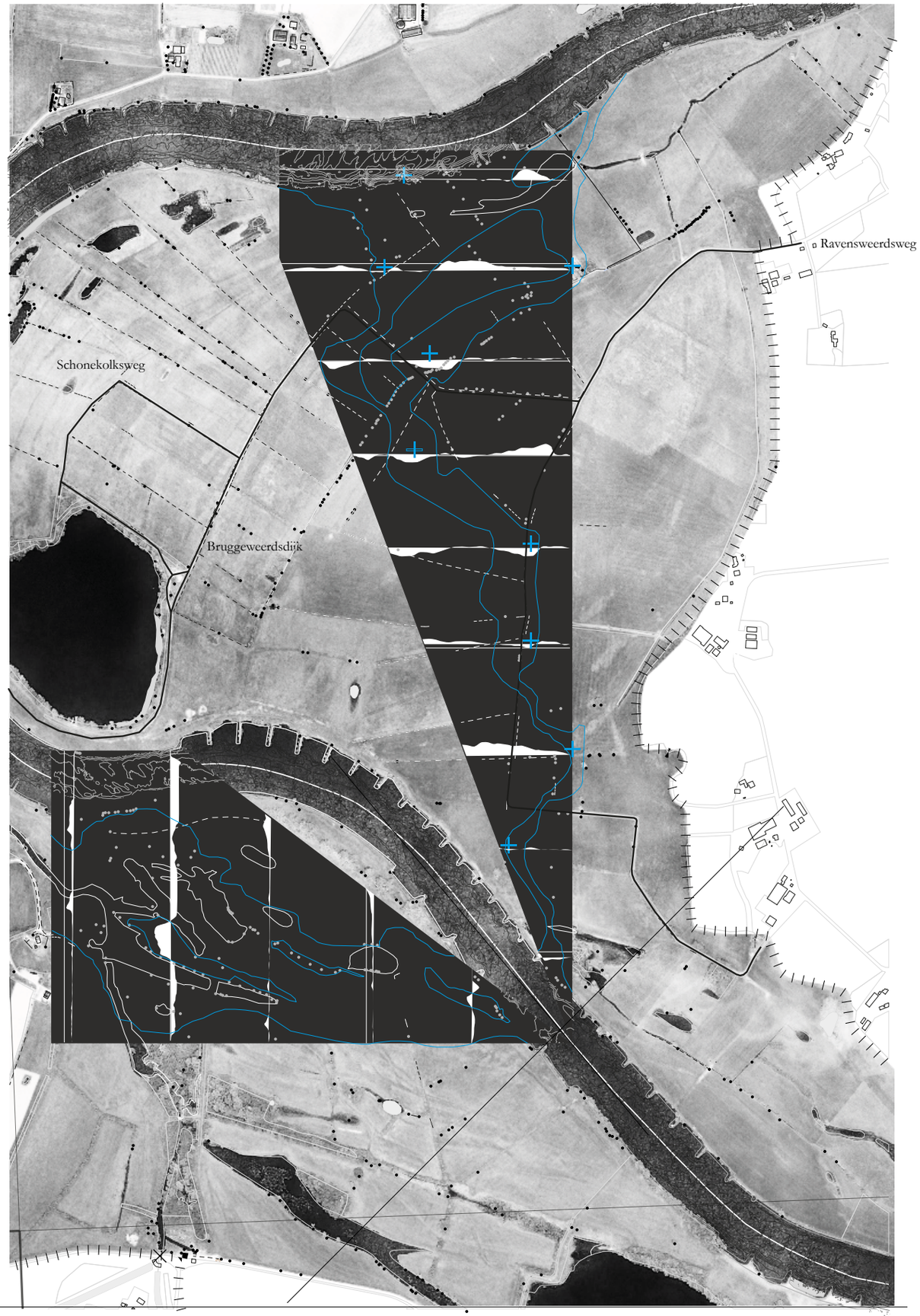
Figure 12: Potentialities of a renaturalizing IJssel riverscape

Figure by Goselink, 2021

When not interfering in the current riverscape, sedimentation of the fairway channel will slightly raise mean water levels but the channel is kept in place by the embankments and groines

In order for the river to renaturalize, sediment and seed transport through lateral translation are key

What happens if the river is forced to create a new, proportionally scaled flowpath?



Design Experiment S
Renaturalizing Riverscape

Figure 13: Functioning of the renaturalizing process in the IJssel landscape

Figure by Goselink, 2021

T = 0

Pathfinding based on microtopography

Overgrown territory

T = 10-20 yrs

Era of rapid meandering

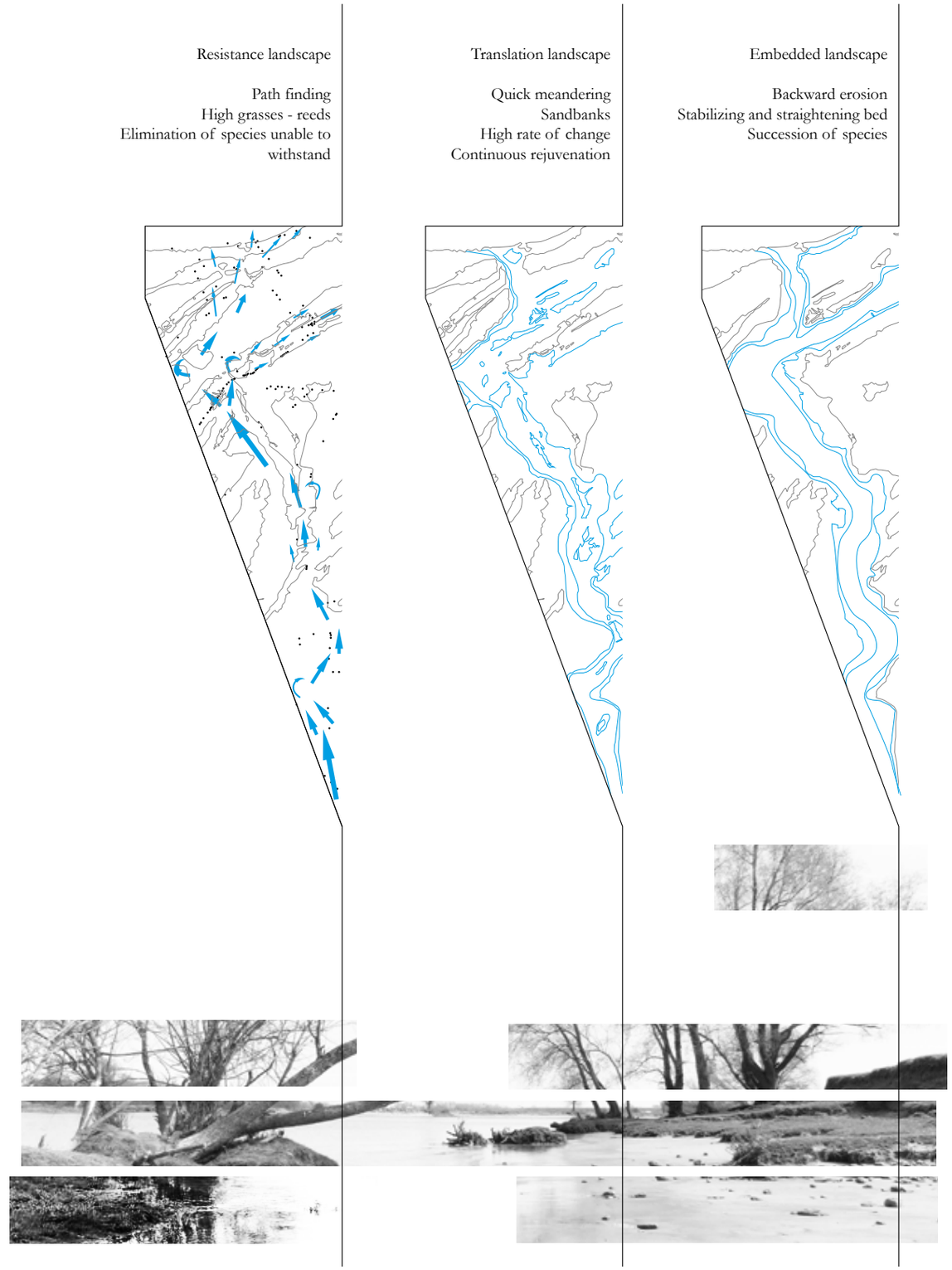
High rate of change and transmission of sediment and seeds longitudinally

Continuous rejuvenation

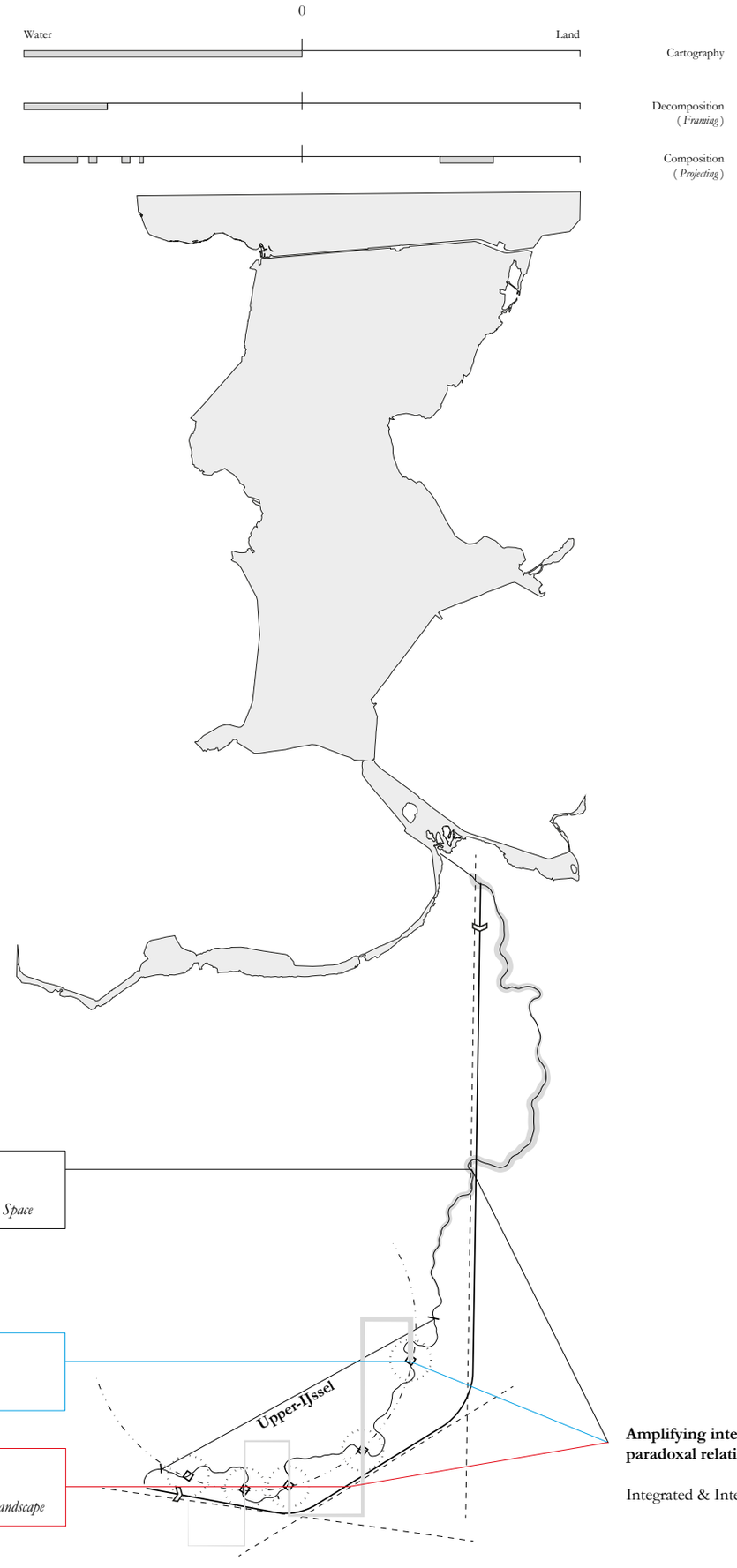
T = 30-40 yrs

Backward erosion straightening the new riverbed

Succession and amassment of species



Working Principle as Spatial Strategy



Working Principle as Spatial Strategy

Figure 14: Implementation of the interaction between opposing systems at Fortmond (O)

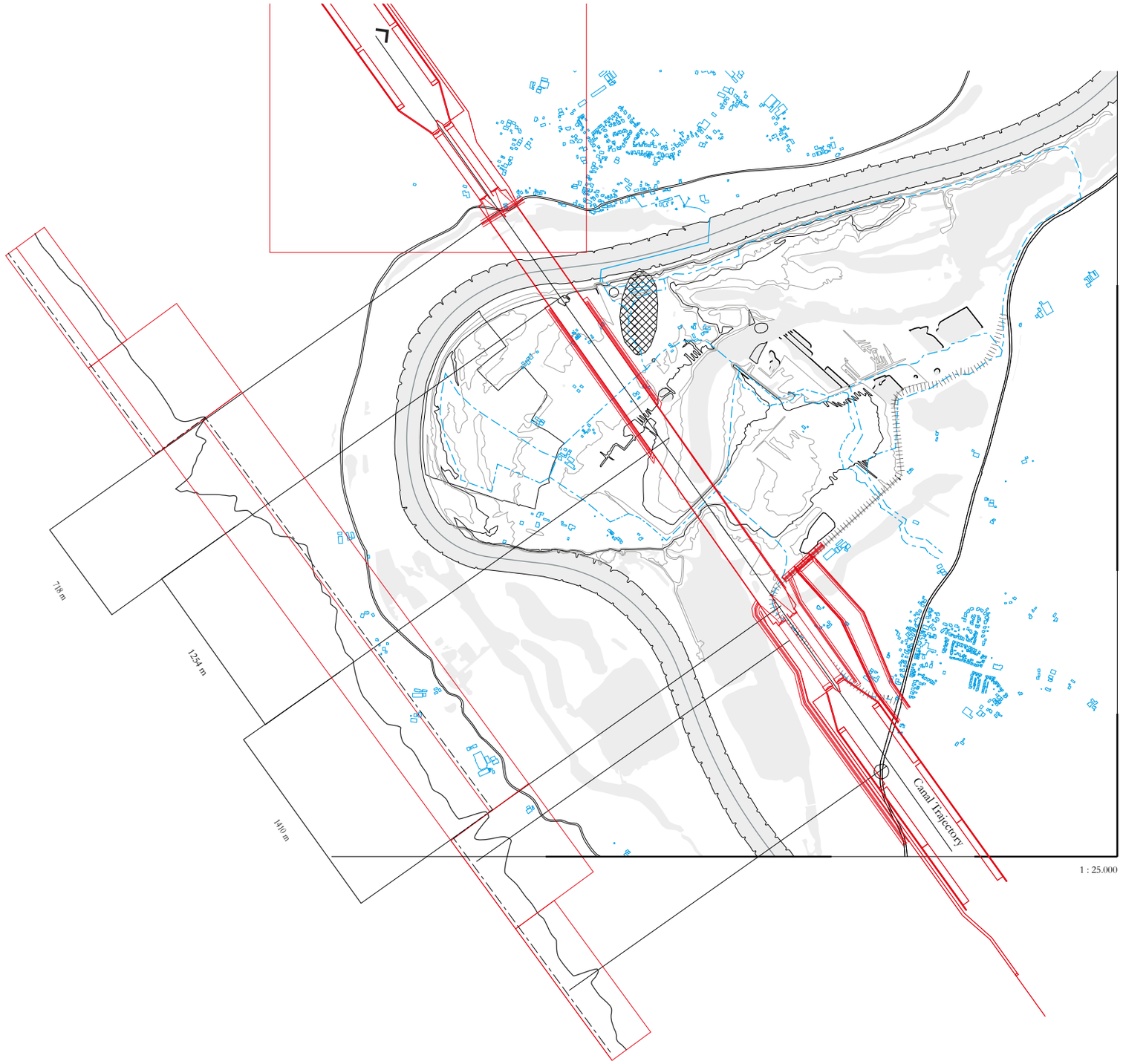
Figure by Goselink, 2021

Problem seeking by deliberately crossing both systems to emphasize their influence on the territorial surroundings

Systemic functioning separated for the navigation canal: Aquaduct

Systemic functioning connected for the secondary channel: Spillway

Integration of connectivity between inner- and outerdike areas through the objects, amplifying (lack of) dynamicity through sequences of motion and perception



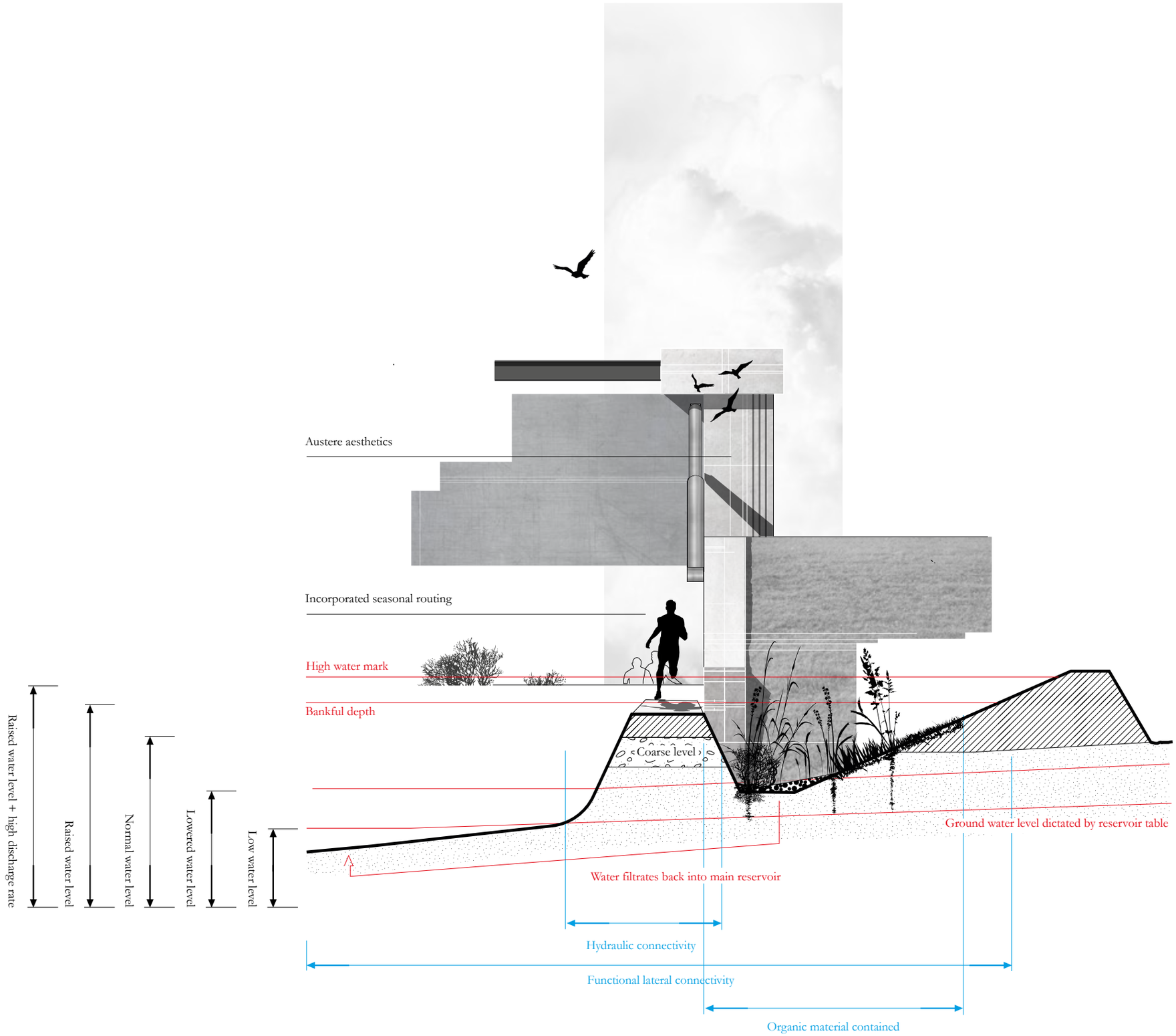
Systemic Connection

Figure 15: Design experiment of the systemic connection between the systems through a spillway

Figure by Goselink, 2021

Proactive problem seeking in the direct confrontation of the central paradox leads to the most challenging design assignment

Deliberately experiencing and emphasizing the difficulties of integrating flow characteristics



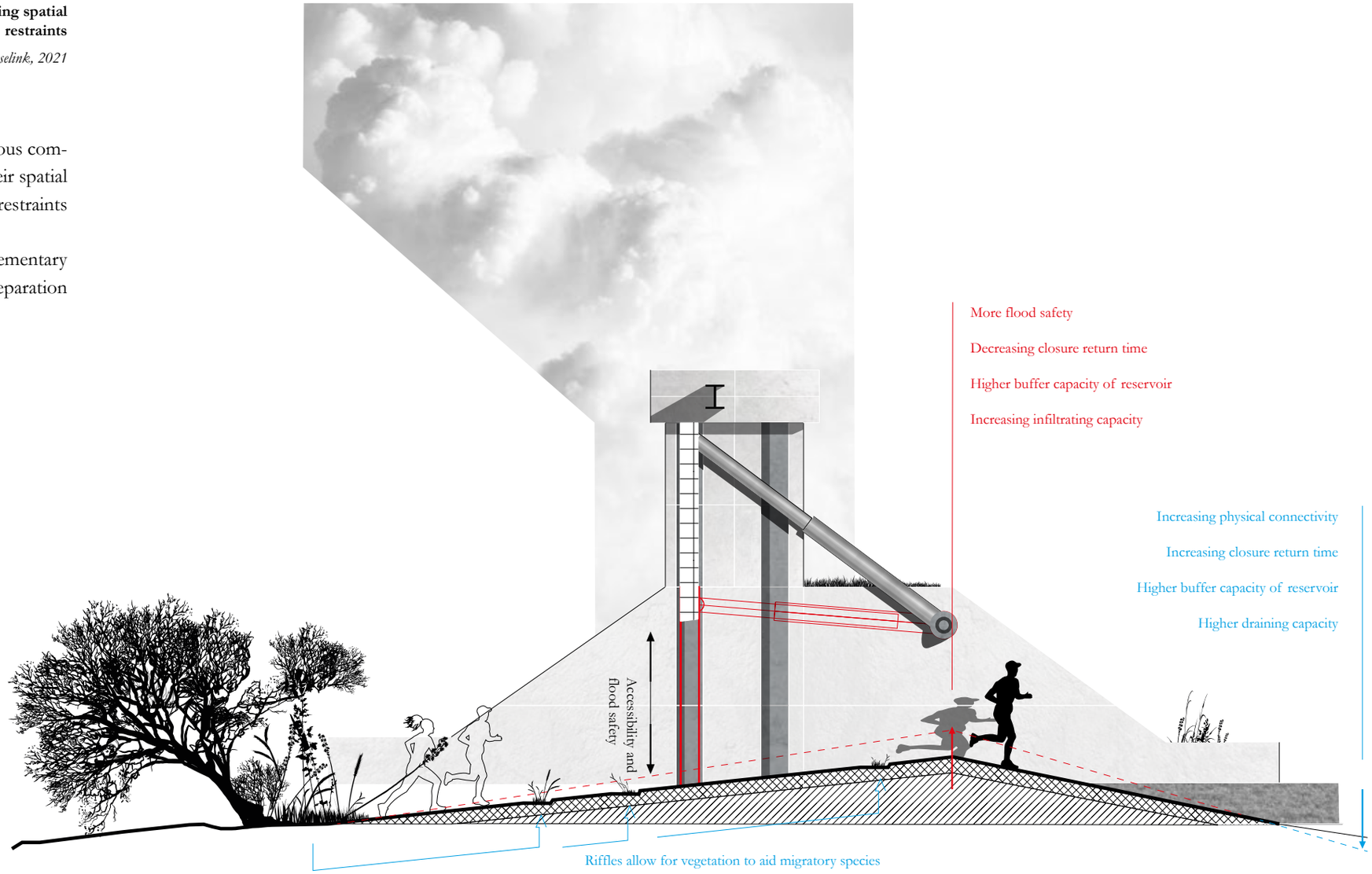
Systemic Connection

Figure 16: Design experiment of the connection of opposing spatial restraints

Figure by Goselink, 2021

Inevibility of increasing complexity alongside continuous compormising when connecting flow characteristics and their spatial restraints

Either / Or situation instead of synthesis between complementary systems in case of separation



Systemic Connection

Figure 17: Conclusion of the design experiment on systemic connection at Fortmond (O)

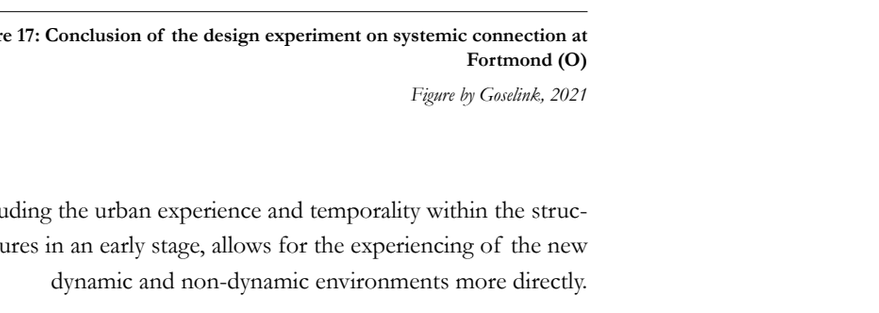
Figure by Goselink, 2021

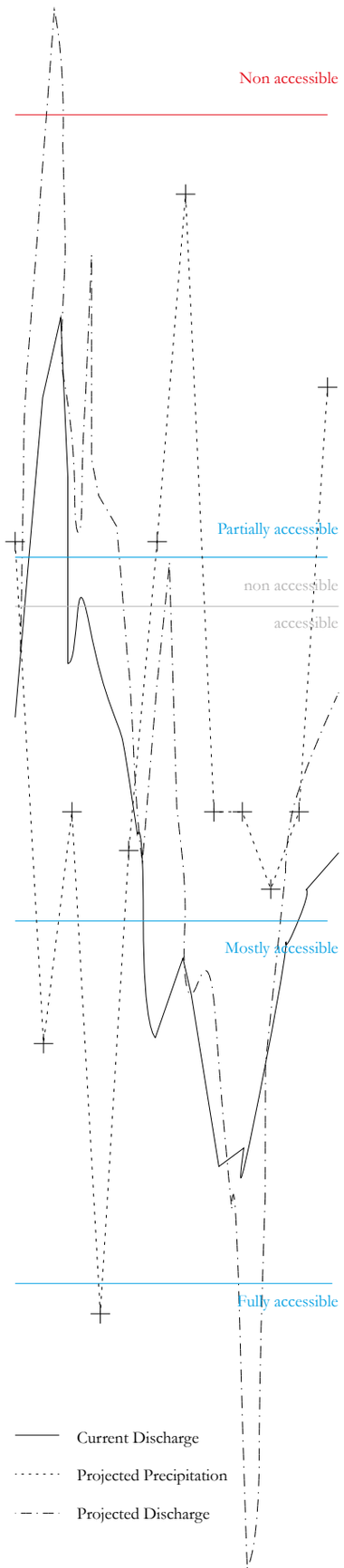
Including the urban experience and temporality within the structures in an early stage, allows for the experiencing of the new dynamic and non-dynamic environments more directly.

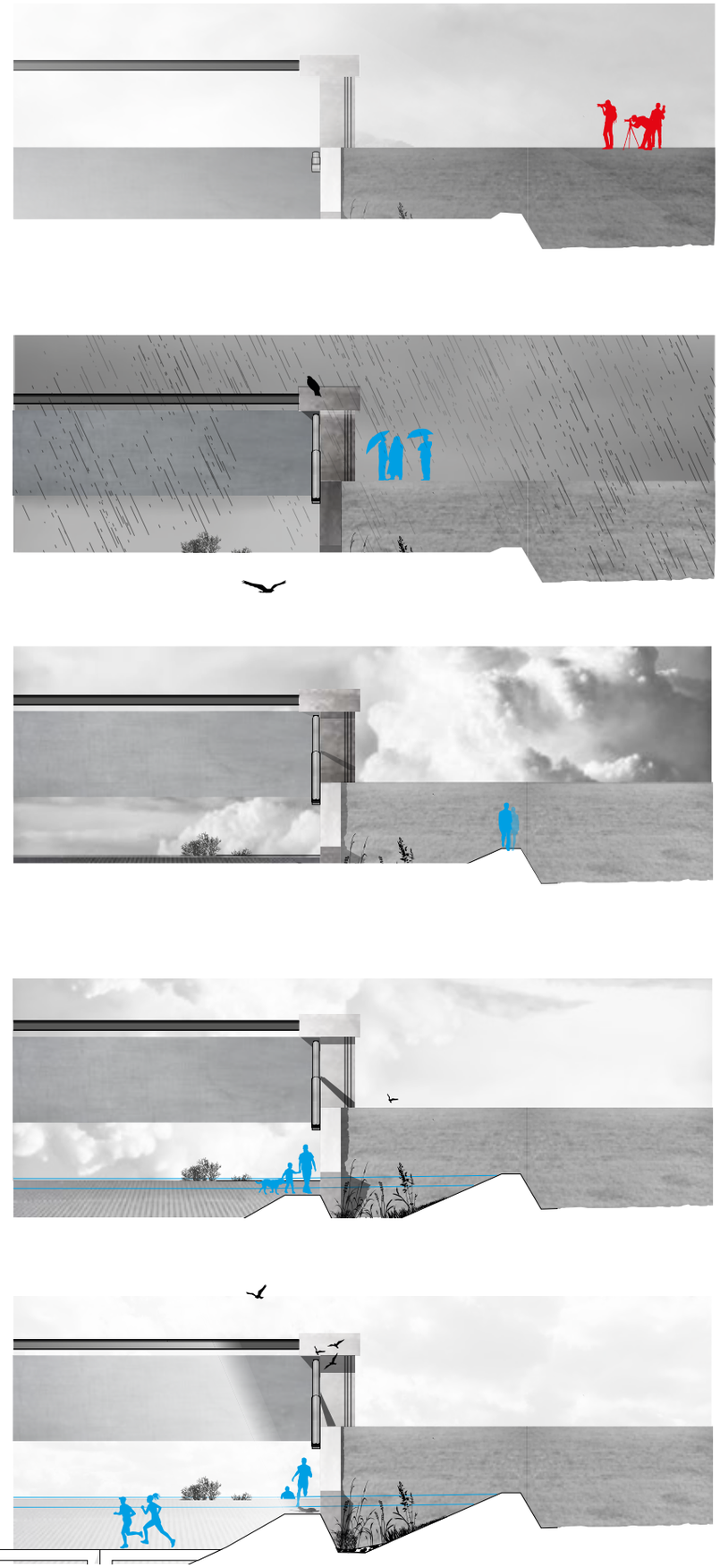
Confronting the core paradox directly, as a part of the solution seeking process typical for designing, leads to interesting design assignments.

However, it also leads to compromising of separate functionalities and the creation of an increasingly complex system of complementary solutions within the integrative design assignment.

Although there are potentialities for synthesizing of the two complementary parallel trajectories on a systemic level, it highlights how this will spatially inevitably lead to compromising and increasing complexity.







Systemic Interaction

Figure 18: Design experiment of the systemic interaction between the systems

Figure by Goselink, 2021

Juxtaposing the infrastructural object to the territory, it provides a new habitat typology foreign to the territory

A bio-receptive concrete facade allows for ecological appropriation of the object while remaining structurally uncompromized

IWT improved to relieve stressors on rail- and roadnetworks

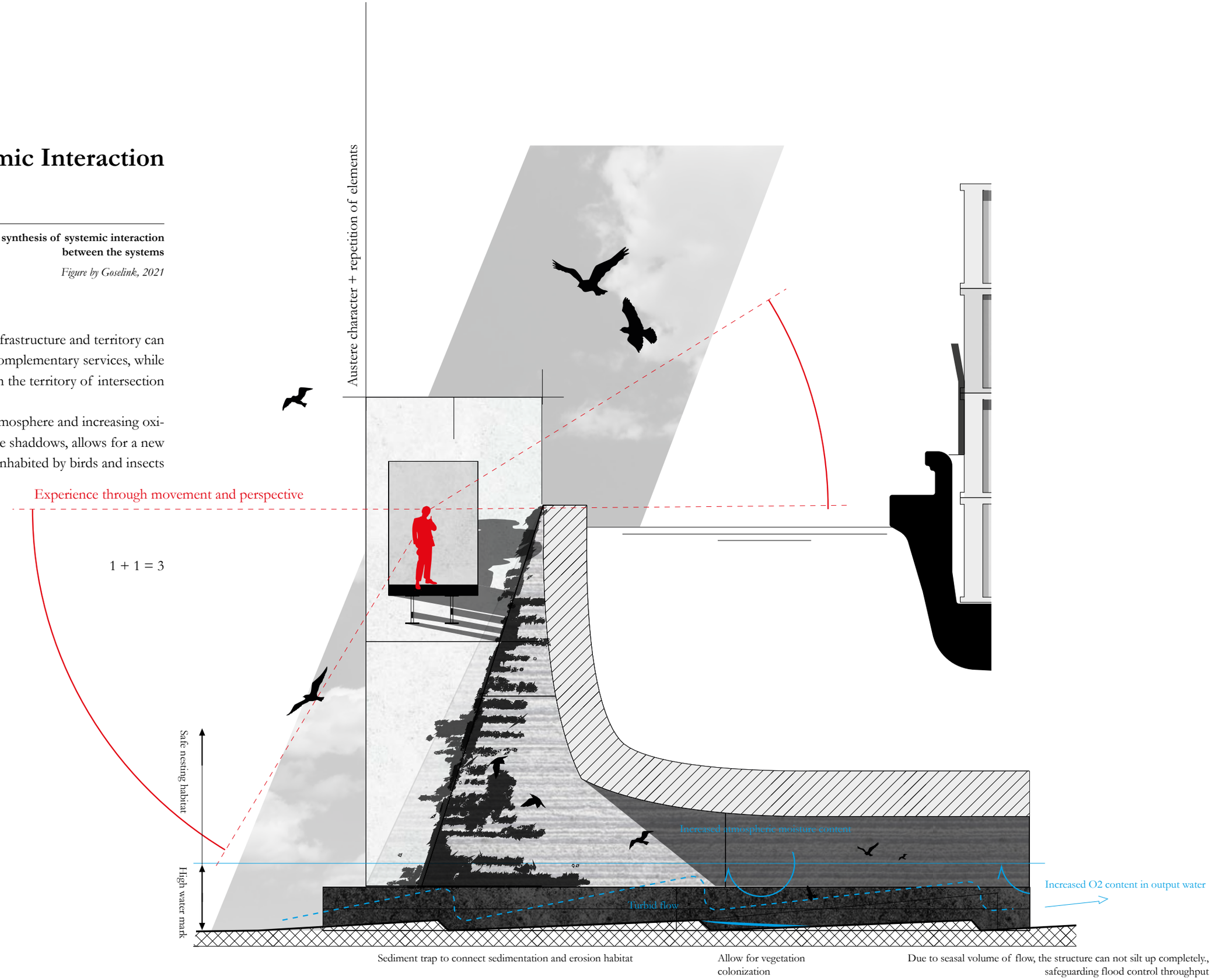
Systemic Interaction

Figure 19: Design experiment of the synthesis of systemic interaction between the systems

Figure by Goselink, 2021

It shows how the separation of infrastructure and territory can lead to systemic synthesis between complementary services, while collateral benefits are obtained in the territory of intersection

Increasing moisture content in the atmosphere and increasing oxigen content in the water while in the shaddows, allows for a new territorial typology to be inhabited by birds and insects



Habitat Creation

Figure 20: Preview of potential habitat development in the IJssel at Fortmond (O)

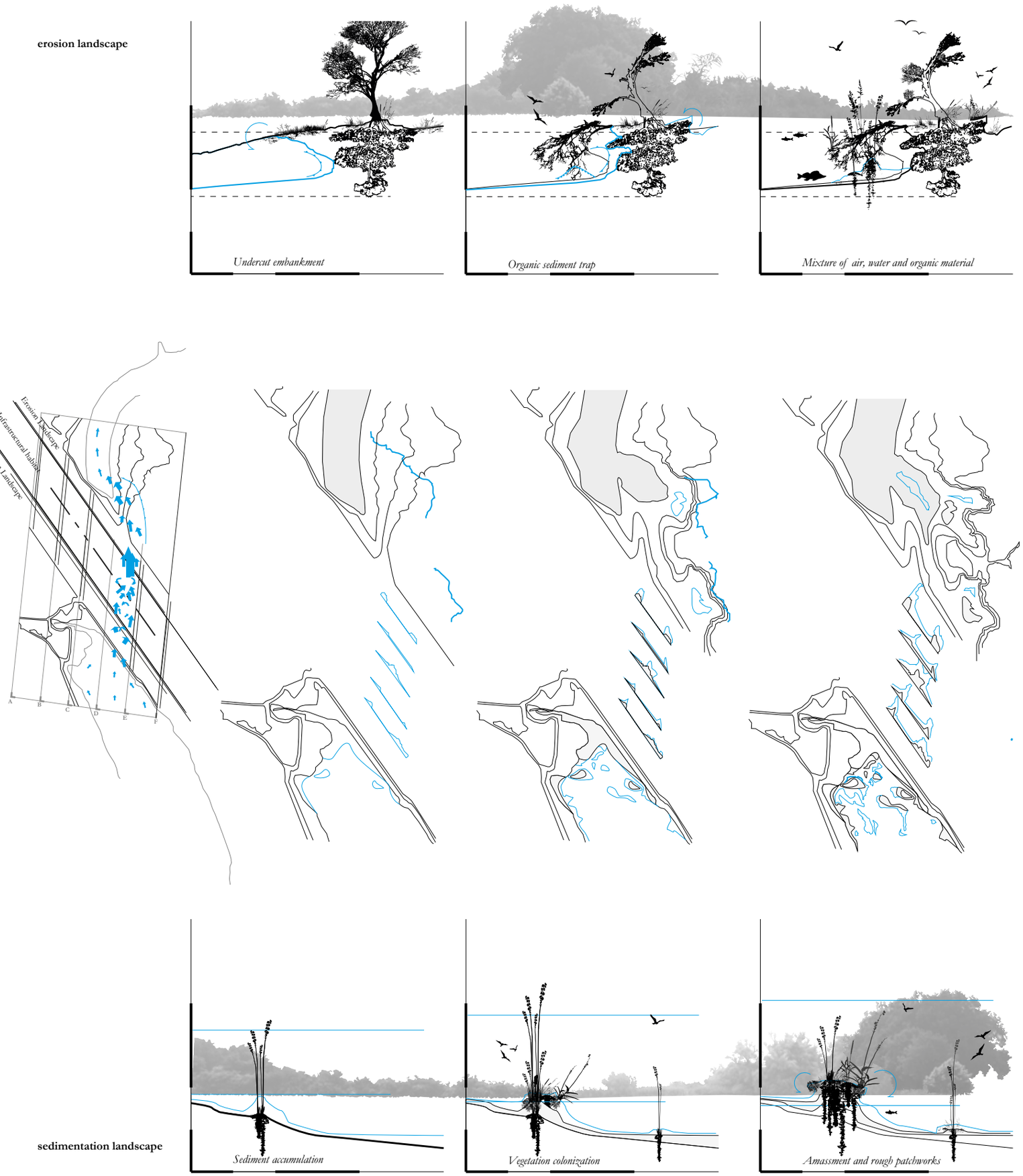
Figure by Goselink, 2021

Interaction between three habitat typologies based on flow characteristics and friction between water and soil

For both the sedimentation and erosion landscapes, the end result consists of a more intricate and omnifarious territorial plane

Biodiversity increases automatically, as new seeds are transported by the sediment streams coming from the S locations upstream in the Upper-IJssel

Flexible landscapes regulate themselves through processes of bio-engineering



Systemic Juxtaposition

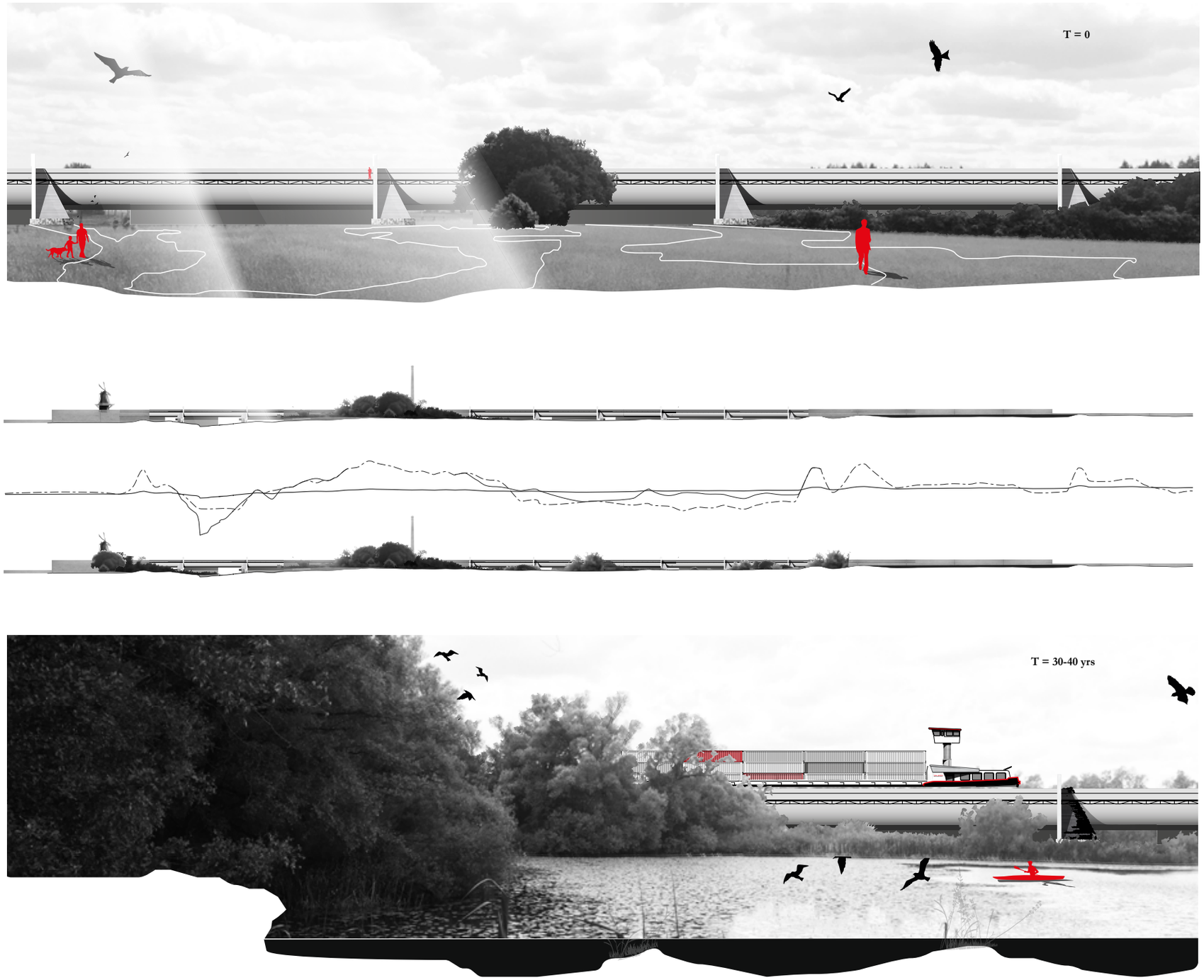


Figure 21: Conclusion of the design experiment on system synthesis

Figure by Goselink, 2021

The design emphasizes the internal paradox of the design assignment as identified through the conscious framing

By extruding the rigid principles from the riverine territory, juxtaposing the two systems based on flow characteristics within the riverine territory shows the increasingly opposing demands

Imagine the immense influence the practice of embedding this spatially restrictive principle within the Dutch riverine territory in relation to other functionalities of rivers

The extrusion and juxtaposition allows the river to renaturalize and absorb the effects of a shifting hydrological cycle, while the complementary parallel system is kept under complete control

Conclusion

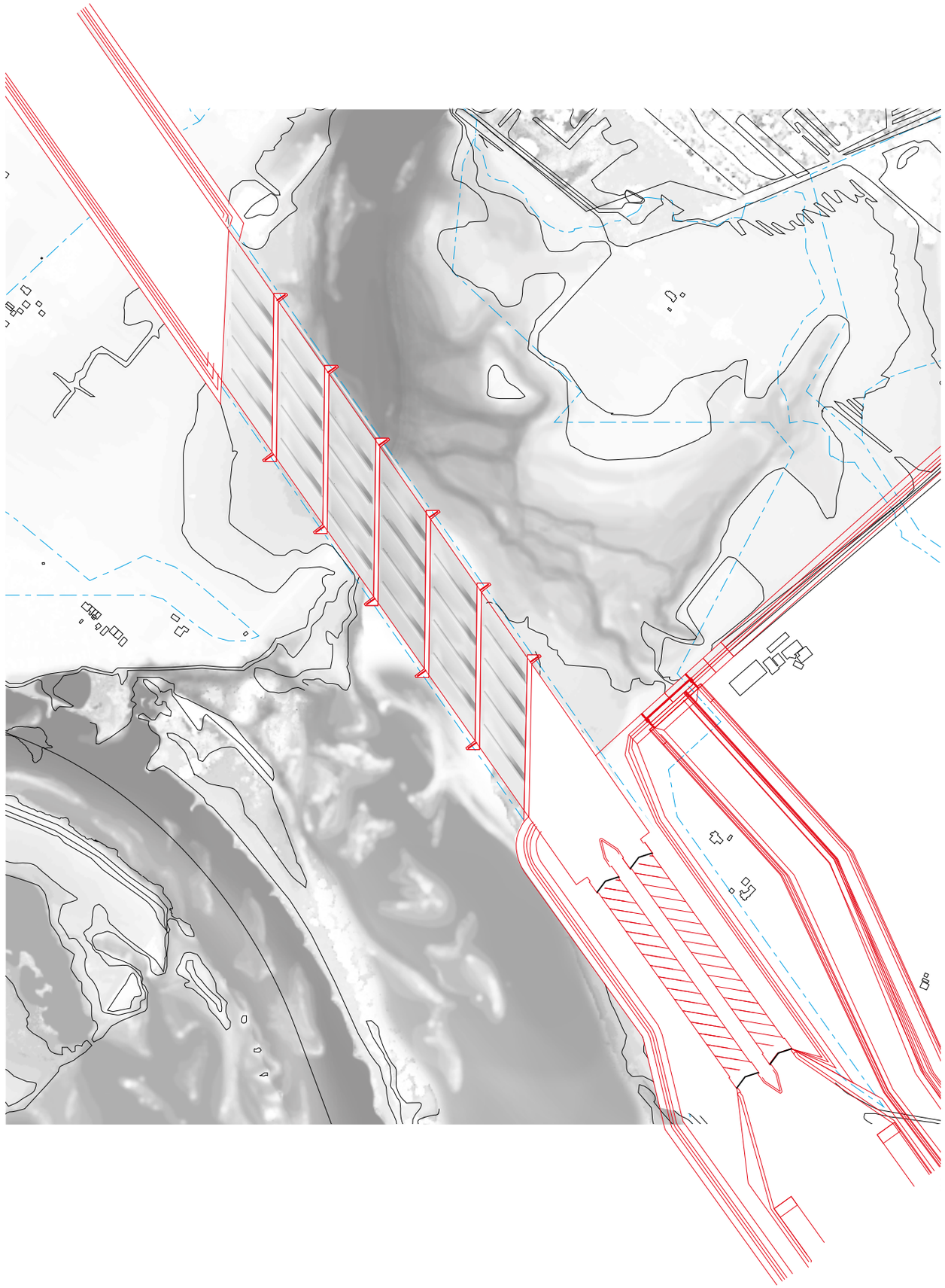


Figure 22: Potential of the design experiments at Fortmond (O)

Figure by Goselink, 2021

How can integrative design of riverine territories with inclusion of socio-technical regimes, result in water management systems adapted to the shifting hydrological cycle, while increasing performance to society?

What

Two separately optimized systems for Navigation + Drought Management and Flood Control + Eco-hydrology

plus Working Principle

Functioning as two complementary parallel systems able to synthesize as a whole on the large scale

leads to Aspired Value

Allow for the adaptation to the shifting hydrological cycle while performance output to society is increased

Conclusion

Figure 23: Result of the design thinking methodology in riverine climate adaptation strategizing

Figure by Goselink, 2021

How can integrative design of riverine territories with inclusion of socio-technical regimes, result in water management systems adapted to the shifting hydrological cycle, while increasing performance to society?

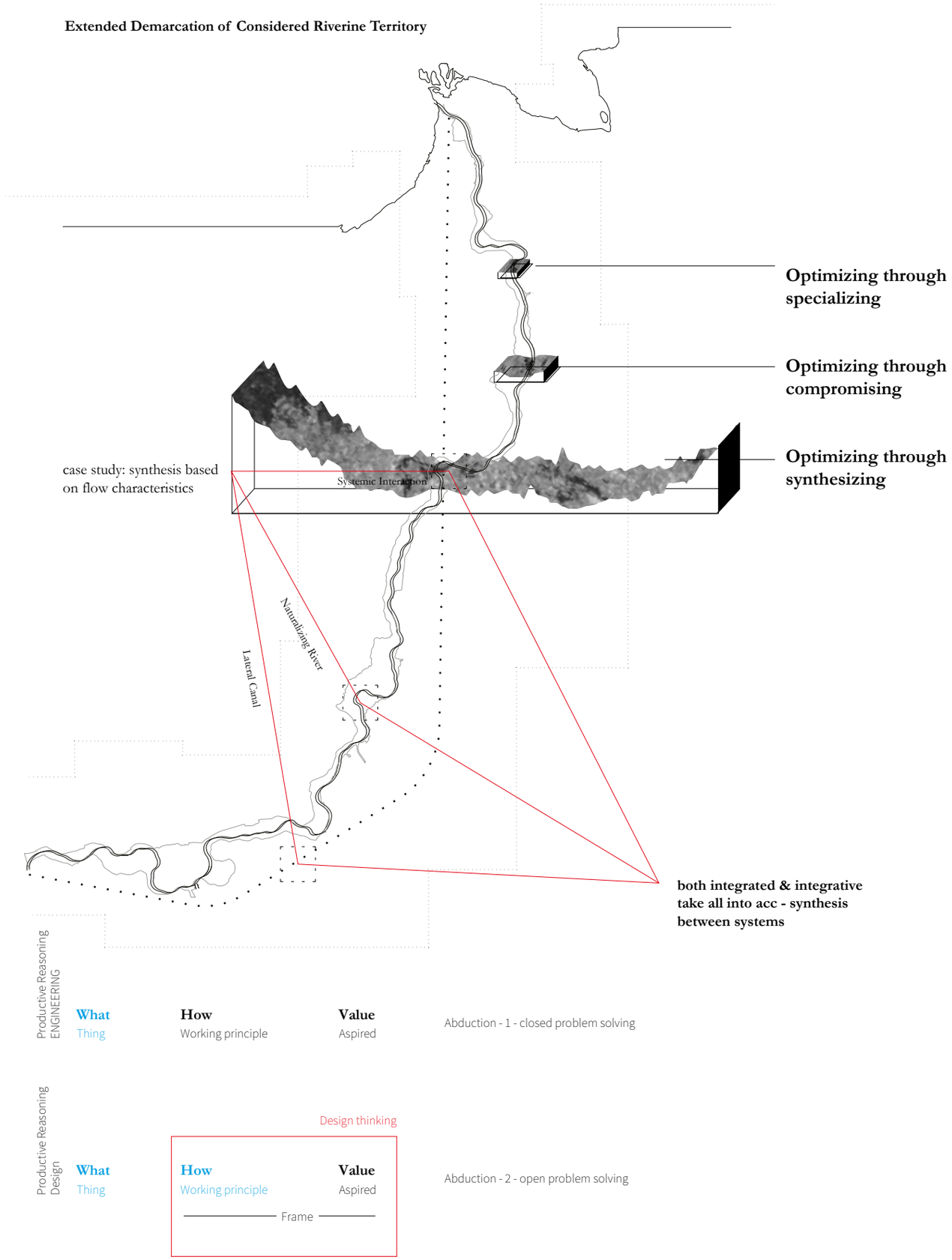
Integrative and Integrated

Due to the framing of the central paradox through multiple themes, design thinking is inherently an integrated approach (Dutch: Integraal)

The integrative approach specifically aims for an end result in which all considered themes are combined, based on synthesis of complementary systems and overall performance increase through reciprocal interrelations instead of compromises: 1 + 1 = 3 (Dutch: Geïntegreerd)

Design allowing for the widening of solution space

By consciously framing the problem and solution simultaneously on a high scale level, allowing for the identification of the phenomenon underlying the central paradox through decomposition and reassembling of the riverine territory, design is able to proactively focus on the widening of solution space and identification of new possibilities and scenarios



Limitations of Decomposition and Abstraction

Figure 24: Contextual boundaries of the design process

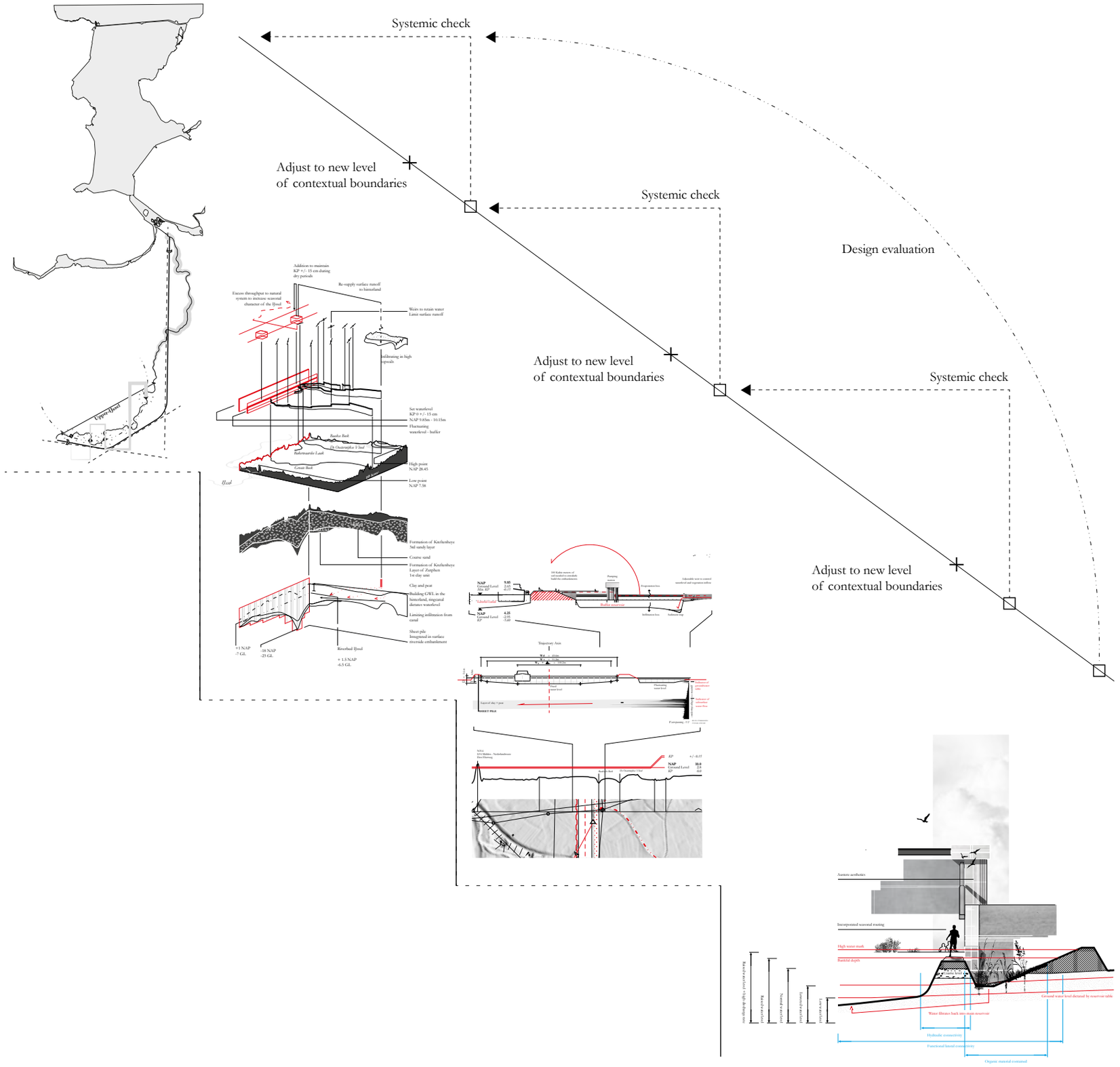
Figure by Goselink, 2021

How can integrative design of riverine territories with inclusion of socio-technical regimes, result in water management systems adapted to the shifting hydrological cycle, while increasing performance to society?

High level of scale and abstraction during the conscious framing of the central paradox, allows for the discovery of a new systemic functioning and spatial reassembly of the system.

Boundaries of decomposition and abstraction are posed by the design process through scales. When designing through the scales, the increasing level of context demands continuous adaptation of the abstract initial reconception

Check: Am I still aiming towards and working towards the aspired value according to the key thesis and following the working principle?



Two-fold Limitation of Territorial Demarcation

Figure 24: The variety of applicable scales on the IJssel

Figure by Goselink, 2021

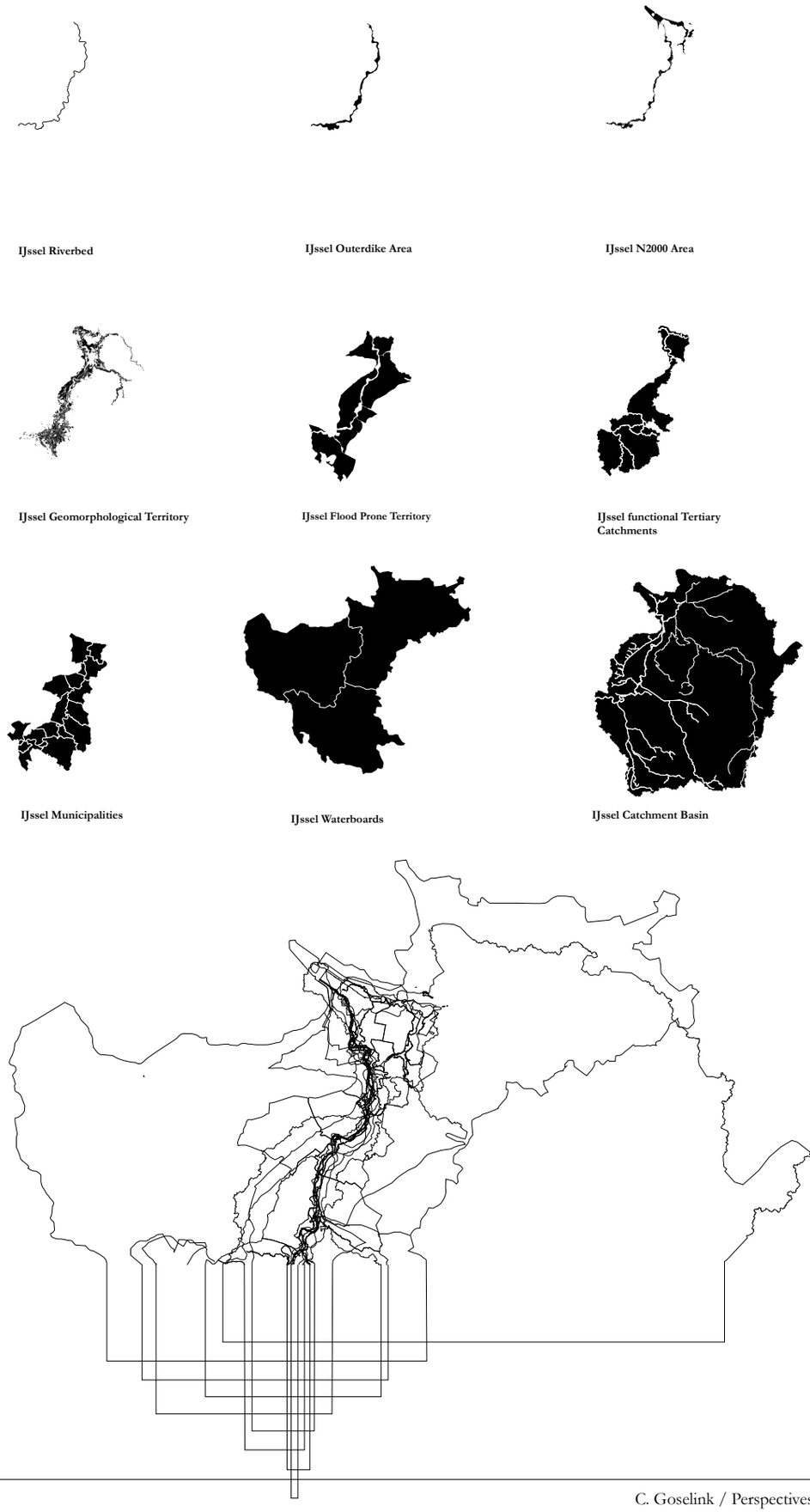
How can integrative design of riverine territories with inclusion of socio-technical regimes, result in water management systems adapted to the shifting hydrological cycle, while increasing performance to society?

Demarcation of what is considered to be the riverine territory limits the project twice

First, the considered territory limits the amount of themes which are taken into account during the act of conscious framing, from which the central paradox and working principle are derived

Second, the physical territory in which the actual intervention is allowed to be placed, places boundaries on the solution space which can be considered

The question remains what can be considered to be the appropriate scale at which the unprecedented scenario of the shifting hydrological cycle should be conceived and approached. This should be a guiding principle in the initial phases of strategizing on climate adaptation **as it defines the potential of widening solution space**



Perspectives on the IJssel