



UNDER PRESSURE: water and the city

adaptive pathways & hybrid green-blue environments

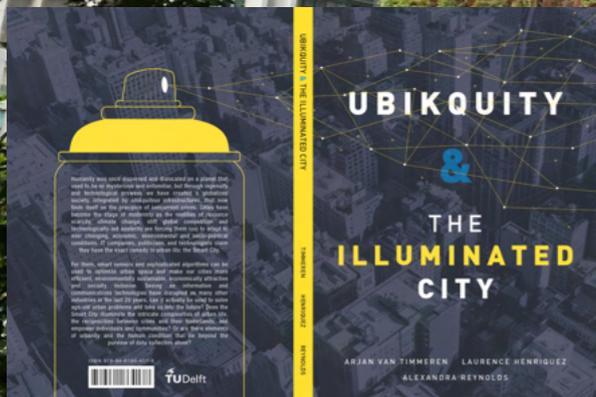
The University of Hong Kong, Faculty of Social Sciences
Jockey Club Water Initiatives on Sustainability and Engagement

International Symposium on Water Sustainability 30 July 2022

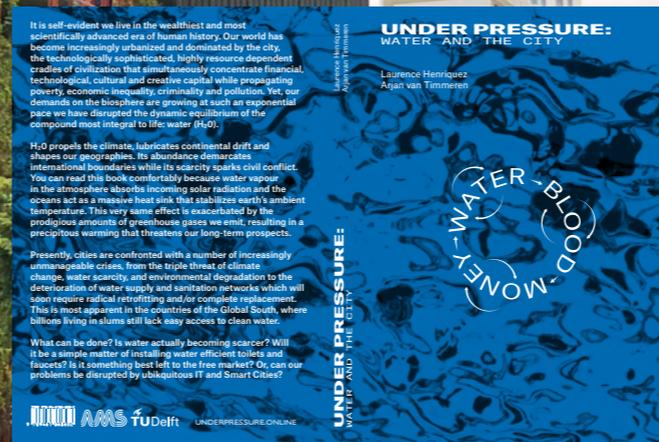
prof.dr.ir. Arjan van Timmeren



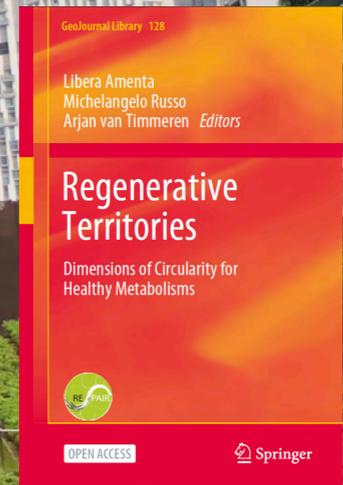
URBAN CLIMATE



PEOPLE & BEHAVIOR



URBAN METABOLISM



It is self-evident we live in the wealthiest and most scientifically advanced era of human history. Our world has become increasingly urbanized and dominated by the city, the technologically sophisticated, highly resource dependent cradles of civilization that simultaneously concentrate financial, technological, cultural and creative capital while propagating poverty, economic inequality, criminality and pollution. Yet, our demands on the biosphere are growing at such an exponential pace we have disrupted the dynamic equilibrium of the compound most integral to life: water (H₂O).

H₂O propels the climate, lubricates continental drift and shapes our geographies. Its abundance demarcates international boundaries while its scarcity sparks civil conflict. You can read this book comfortably because water vapour in the atmosphere absorbs incoming solar radiation and the oceans act as a massive heat sink that stabilizes earth's ambient temperature. This very same effect is exacerbated by the prodigious amounts of greenhouse gases we emit, resulting in a precipitous warming that threatens our long-term prospects.

Presently, cities are confronted with a number of increasingly unmanageable crises, from the triple threat of climate change, water scarcity, and environmental degradation to the deterioration of water supply and sanitation networks which will soon require radical retrofitting and/or complete replacement. This is most apparent in the countries of the Global South, where billions living in slums still lack easy access to clean water.

What can be done? Is water actually becoming scarcer? Will it be a simple matter of installing water efficient toilets and faucets? Is it something best left to the free market? Or, can our problems be disrupted by ubiquitous IT and Smart Cities?

Laurence Henriquez
Arjan van Timmeren

UNDER PRESSURE: WATER AND THE CITY

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UNDER PRESSURE:
WATER AND THE CITY



UNDERPRESSURE.ONLINE





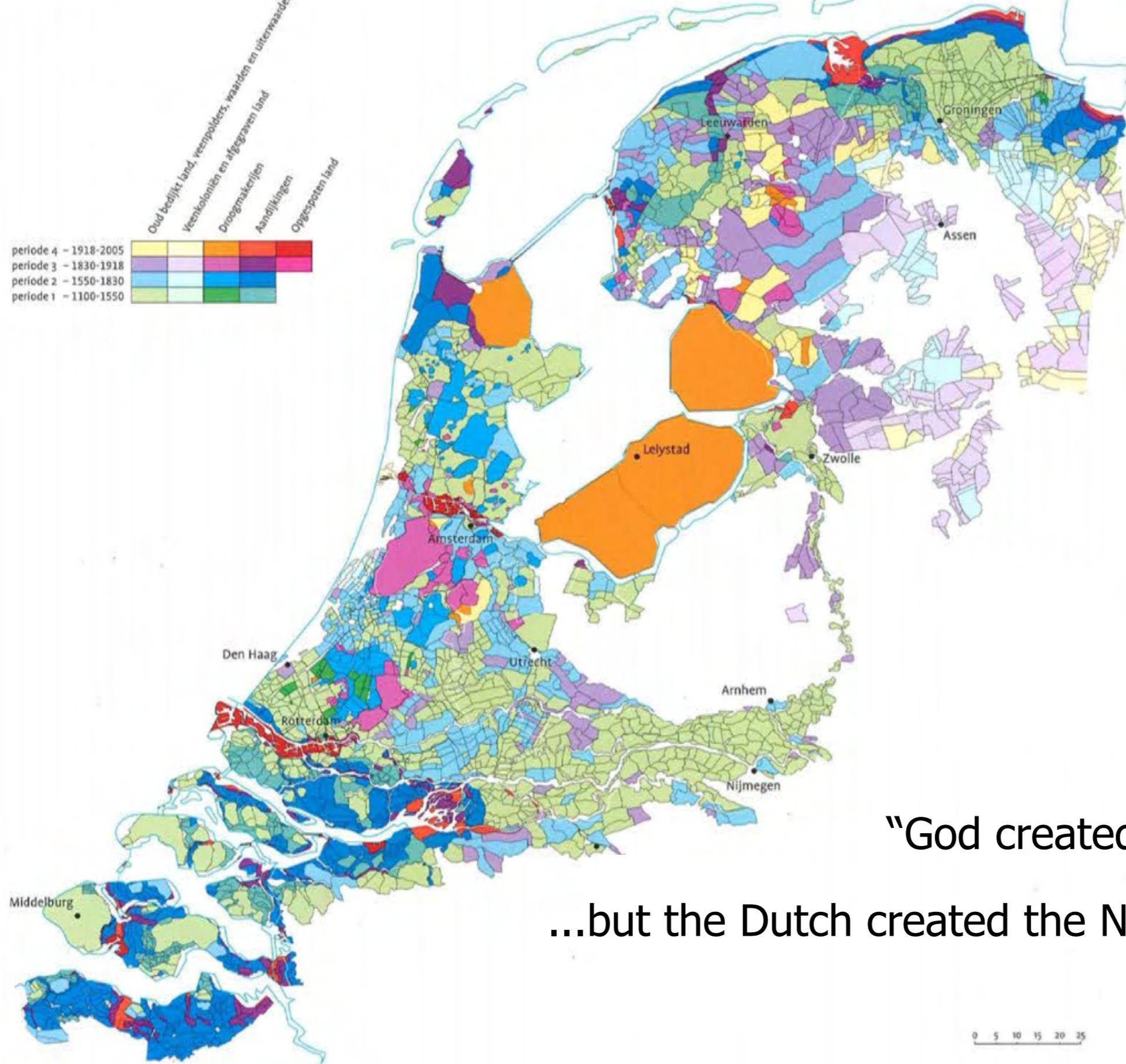
Room for the River and Value of Climate Adaptiveness & new spatial solutions / (hybrid) Green-Blue environments



1.

a resilient / sustainable urban delta

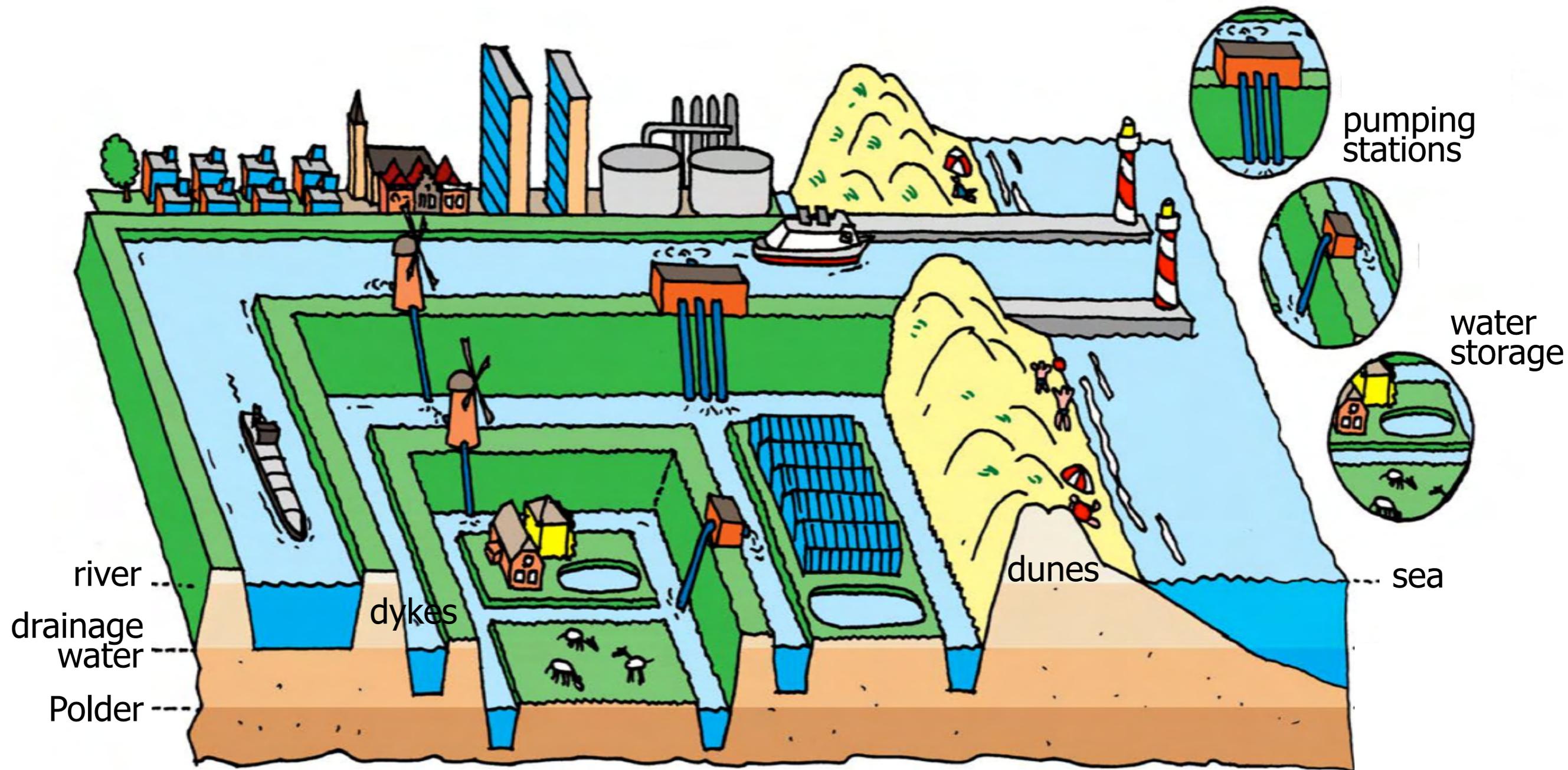
explained via the 'IJssel'-'Vecht' Delta (northern delta, the Netherlands)



“God created the Earth,
 ...but the Dutch created the Netherlands!”

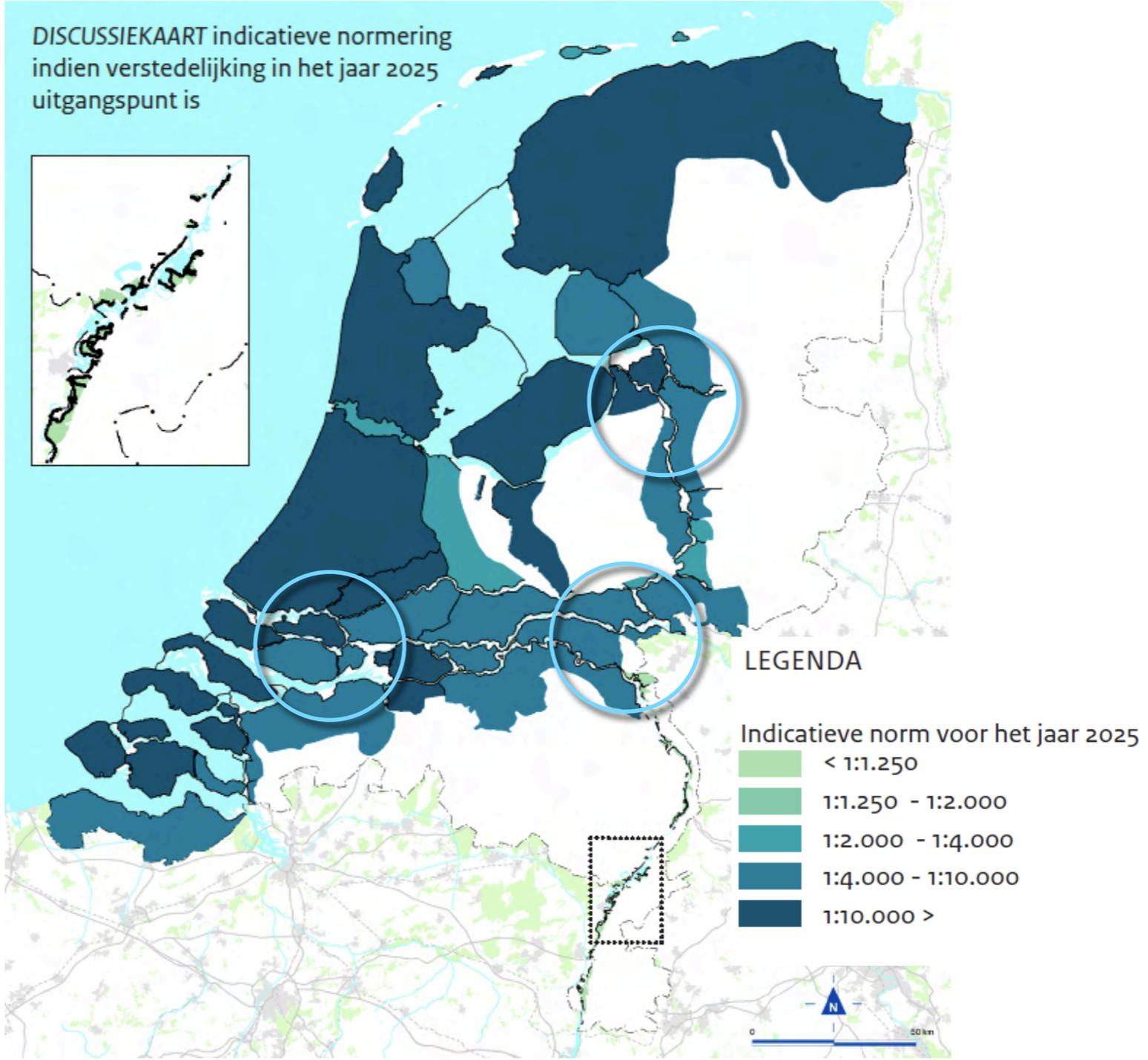
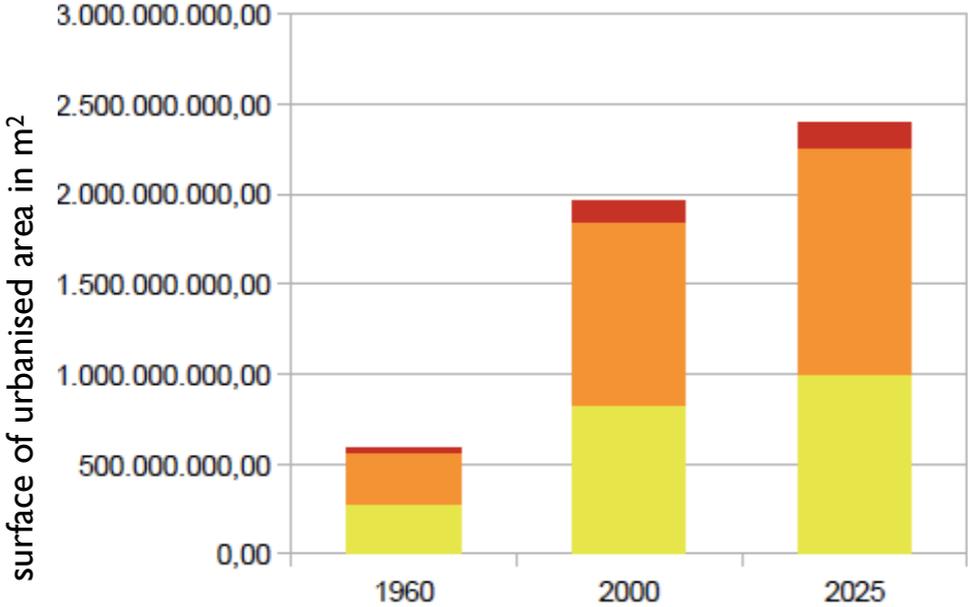
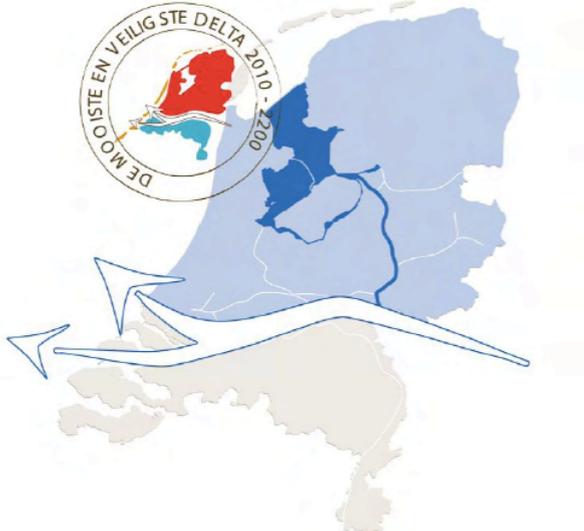
Water Infrastructure in NL... ports & polders

schematic overview of the Dutch polder system



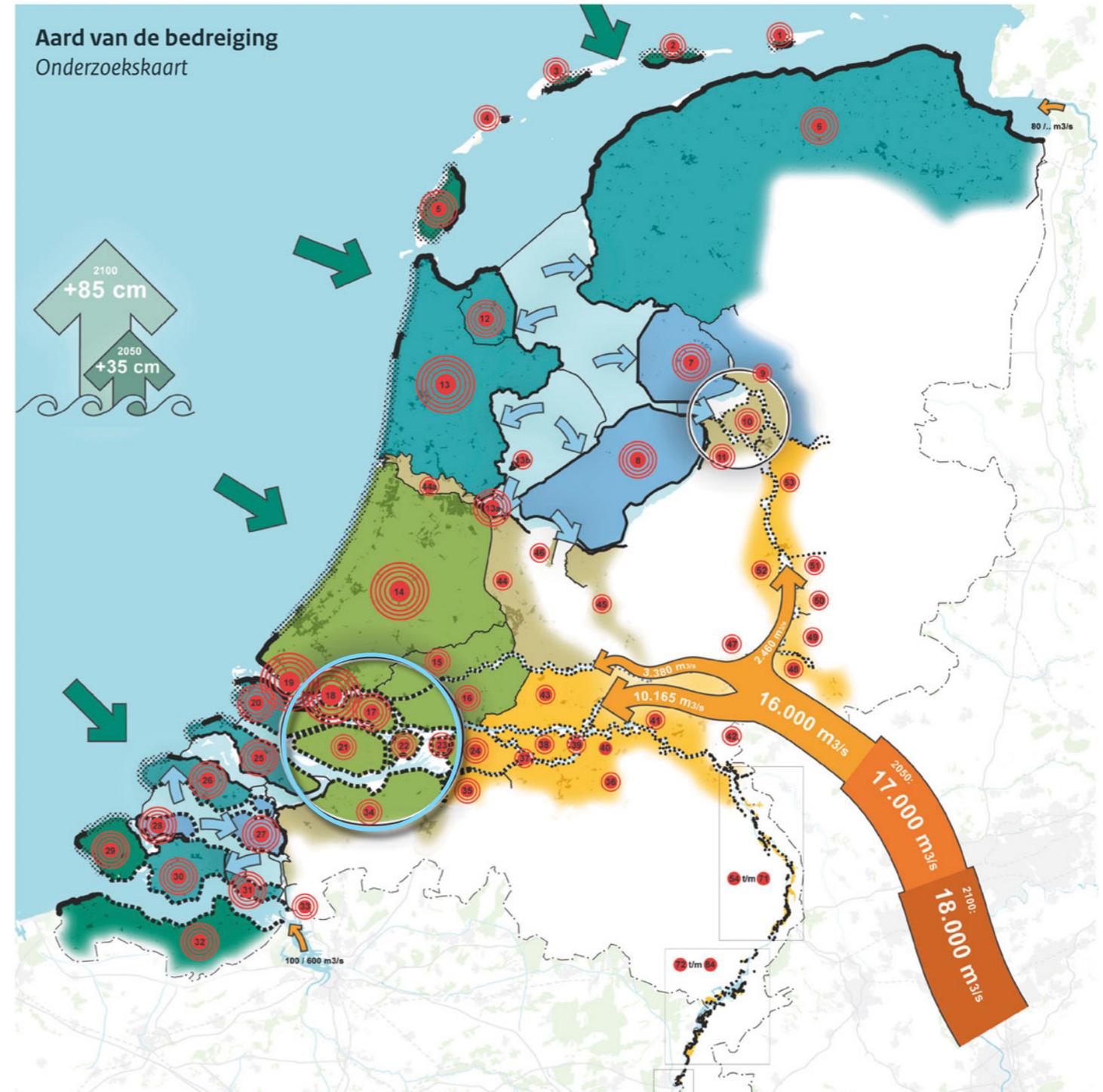
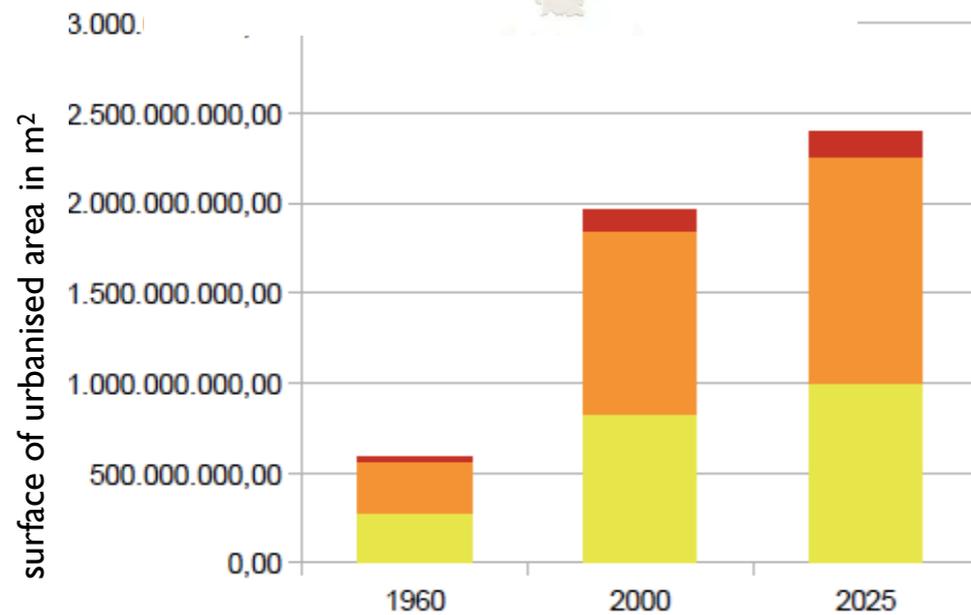
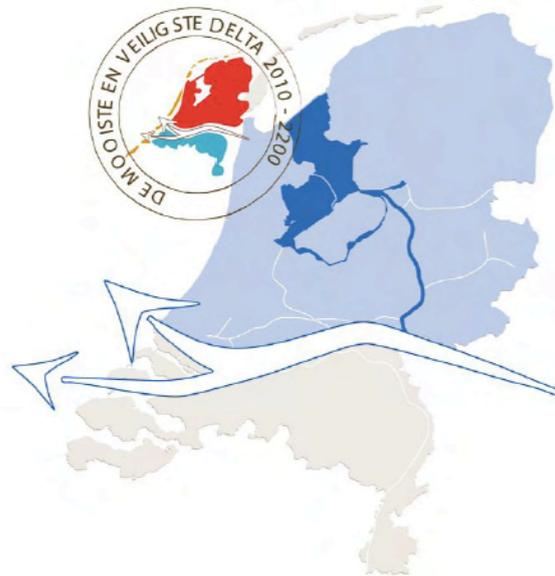
The two main Dutch Deltas ...

the largest sweet water reserve of northern Netherlands (mainly river 'Ijssel' as influx)



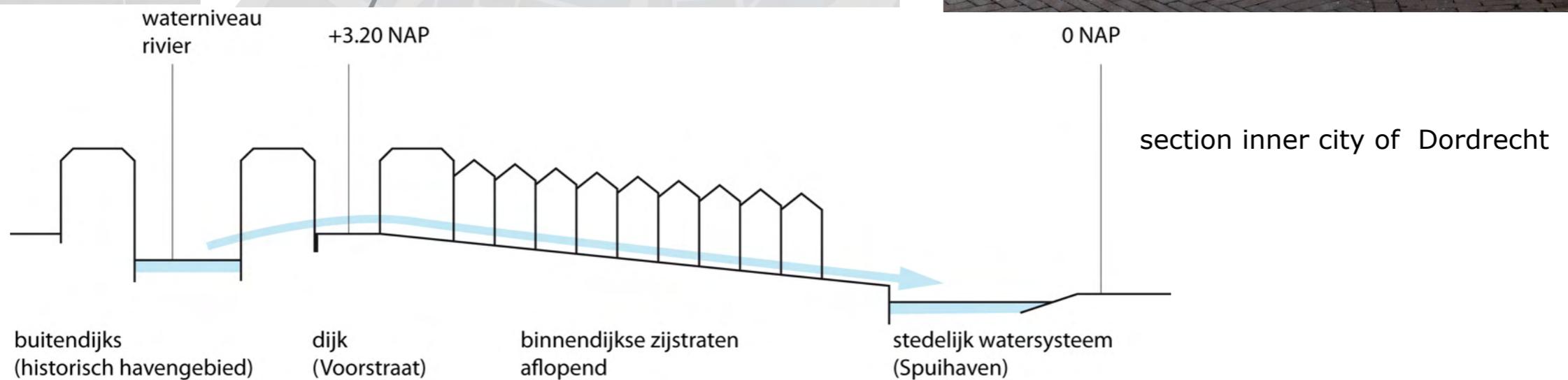
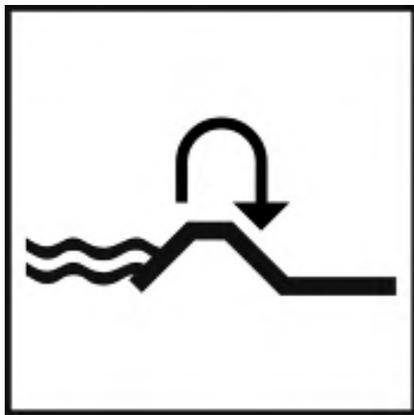
The southern delta (Rotterdam/Dordrecht)

the largest sweet water reserve of northern Netherlands (mainly river 'Ijssel' as influx)



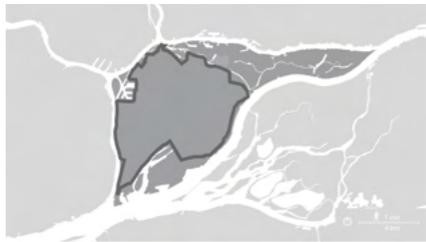
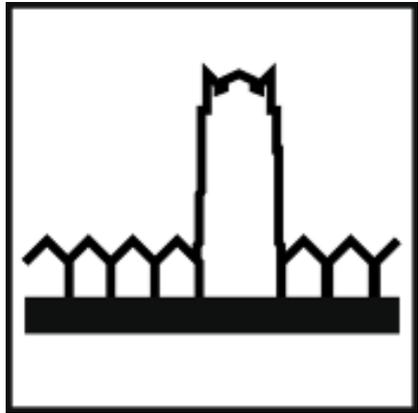
The southern delta (Rotterdam/Dordrecht)

another approach to the water tasks: adaptation

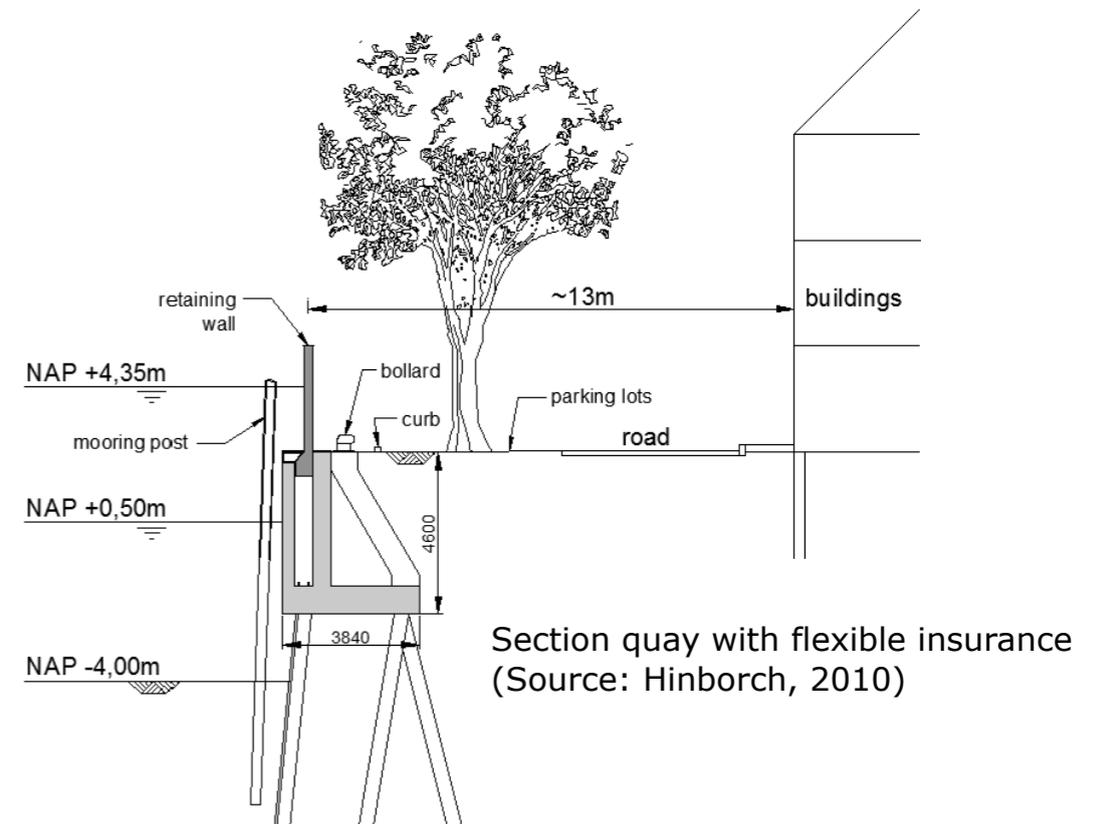


The southern delta (Rotterdam/Dordrecht)

another approach to the water tasks: adaptation



Topography: relative closed waterfront



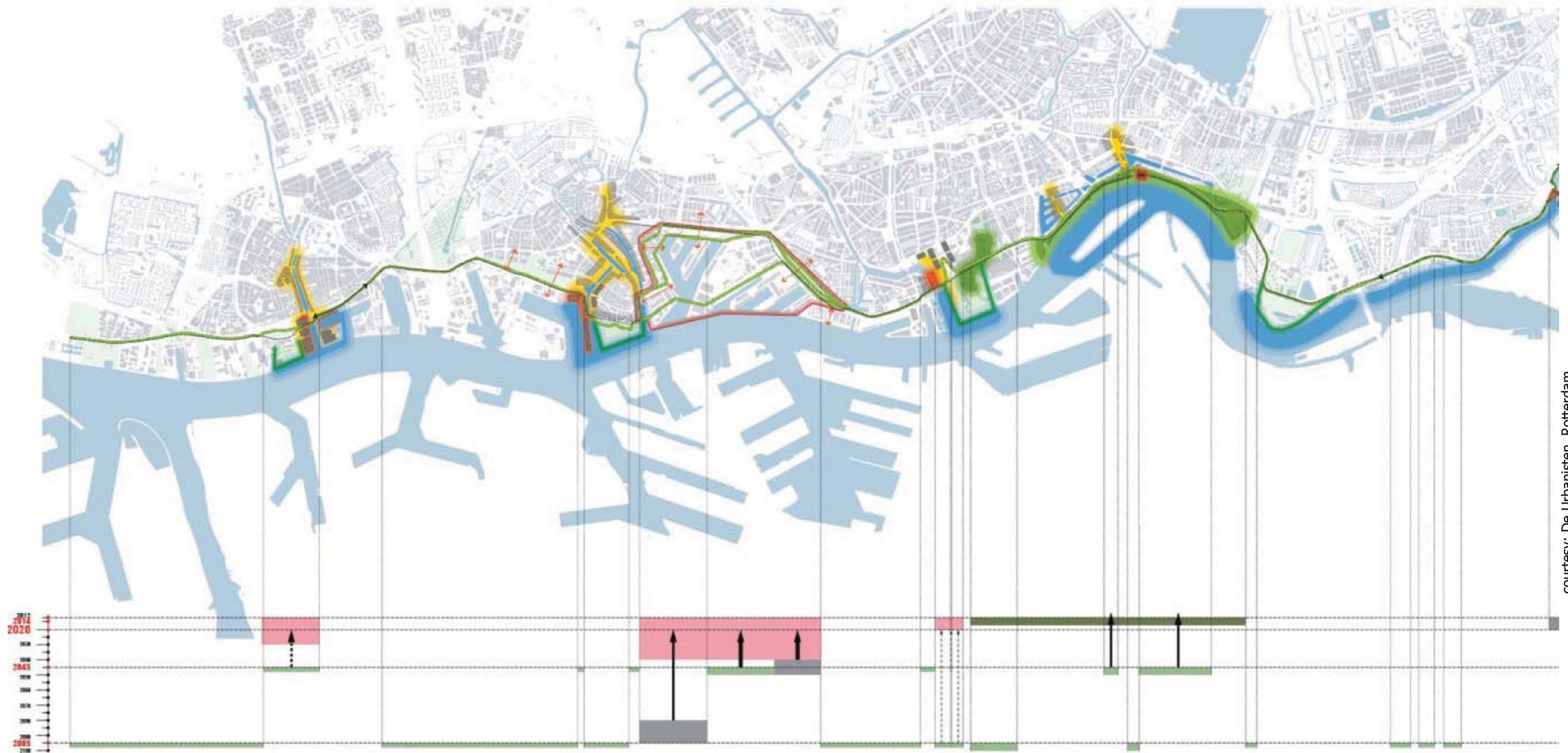
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The southern delta (Rotterdam/Dordrecht)



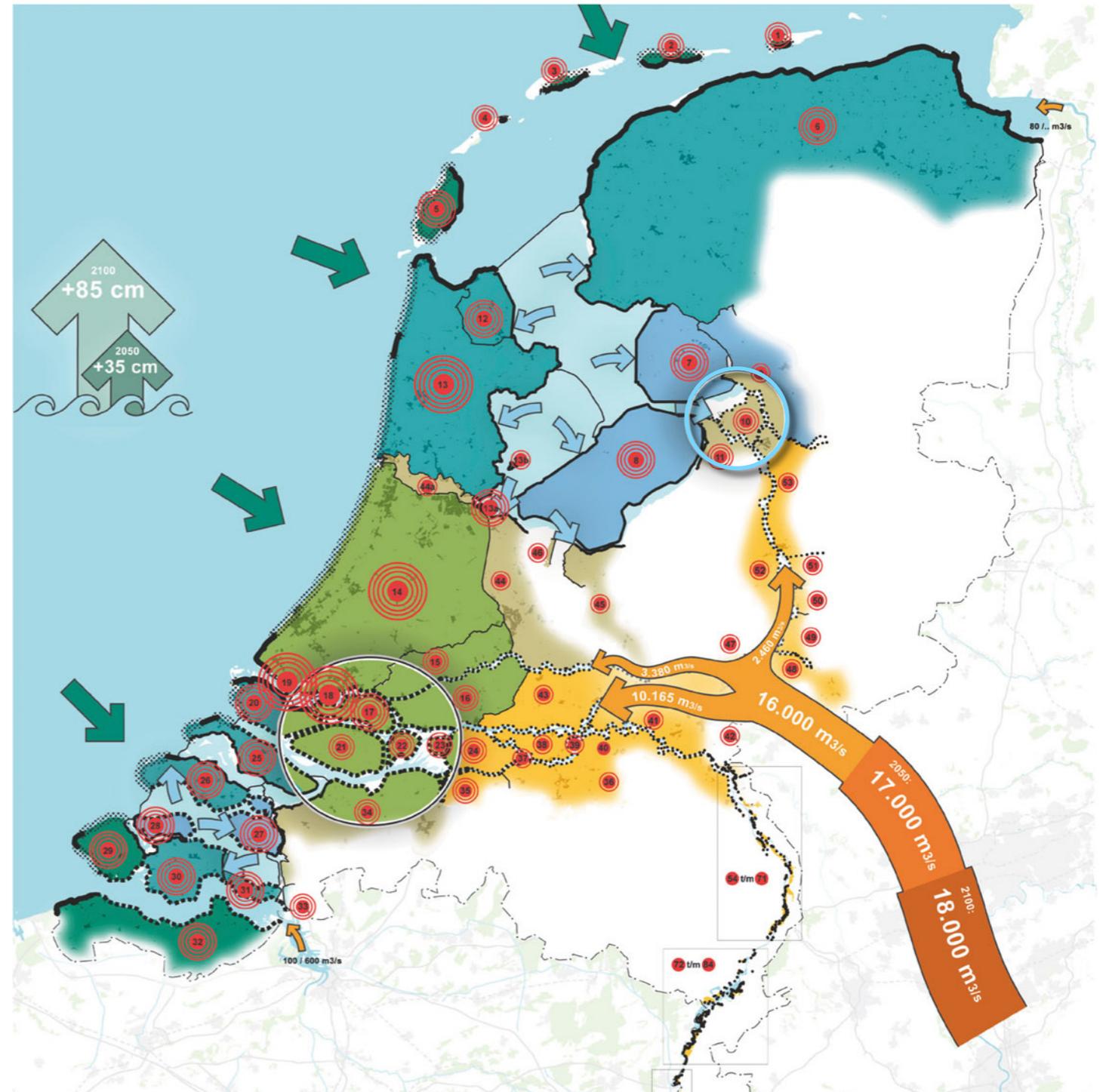
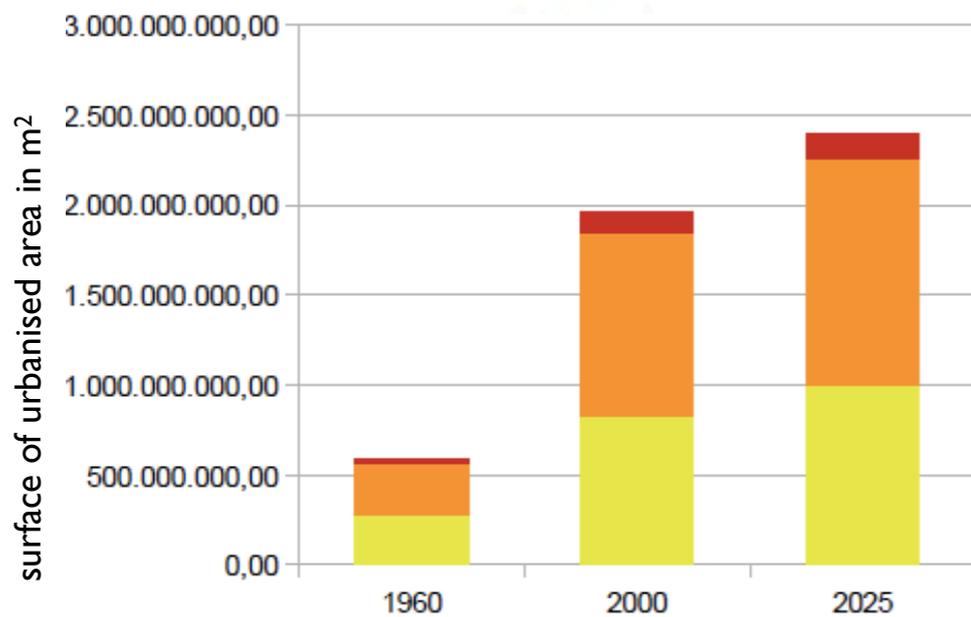
The southern delta (Rotterdam/Dordrecht) connecting water adaptation tasks to spatial planning ...



courtesy: De Urbanisten, Rotterdam

The northern Dutch 'IJssel-Vecht'delta

the largest sweet water reserve of northern Netherlands (mainly river 'IJssel' as influx)





Plangebied verkenning lange termijn perspectieven IJssel-Vechtdelta

courtesy: H+N+S Landschapsarchitecten



photo / copyright: Climate Campus Zwolle



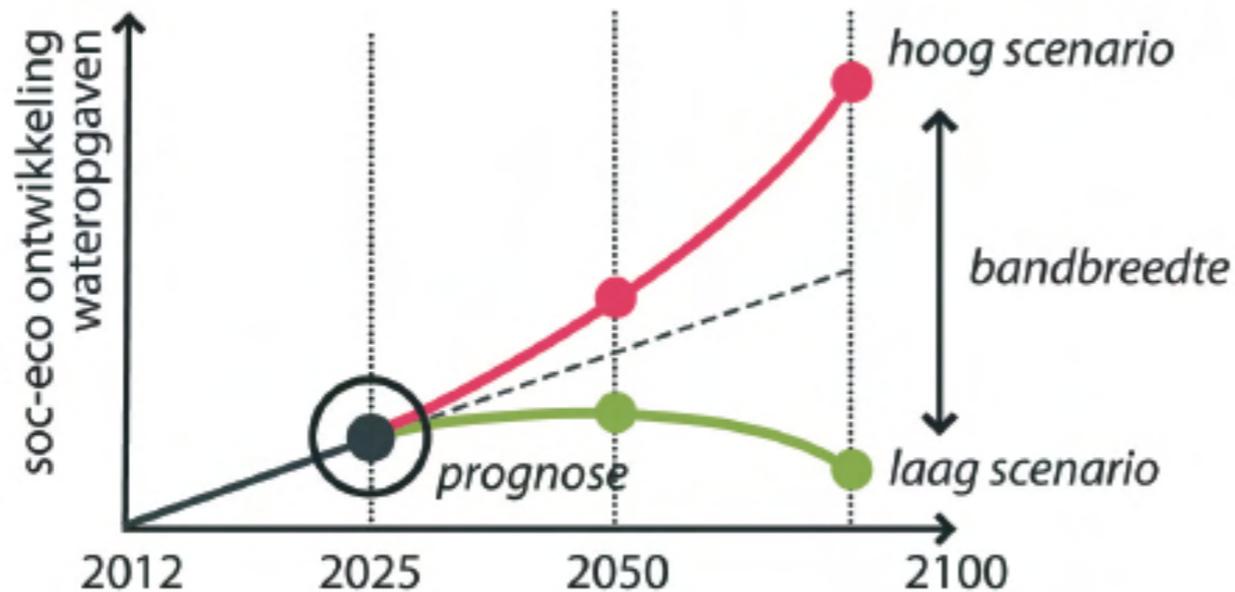


photo / copyright: Climate Campus Zwolle

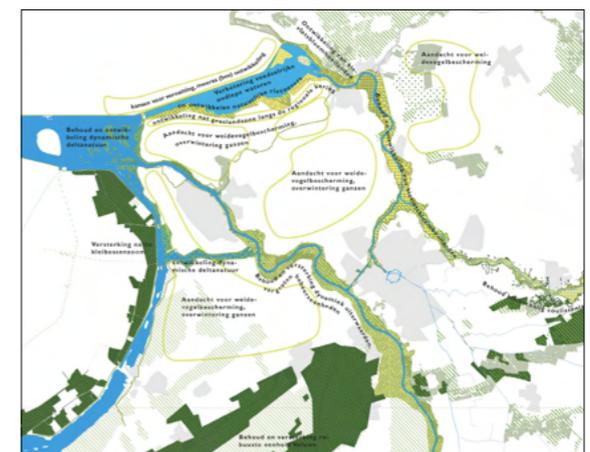
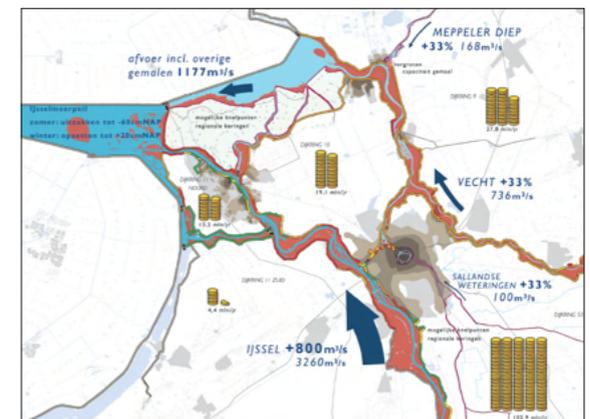
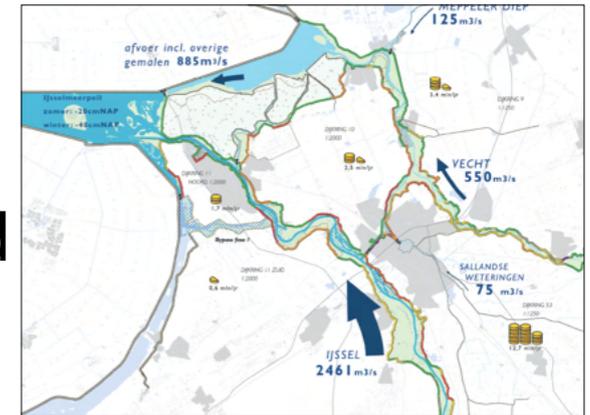
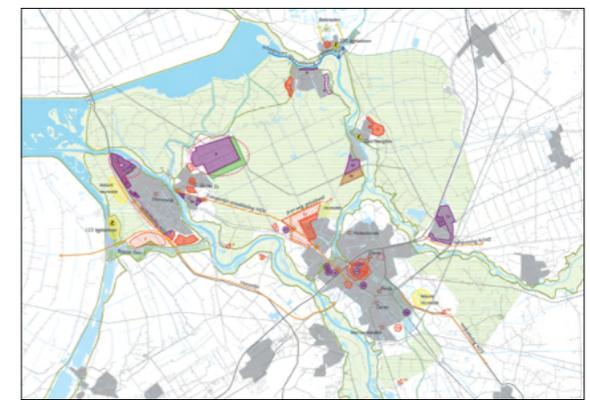
Dutch 'IJssel-Vecht'delta

Climate adaptation in Urban Deltas

- * Looking for synergies between water related tasks and other spatial developments
- * From Static planning towards Adaptive Planning
- * Distinction between prognoses and scenarios

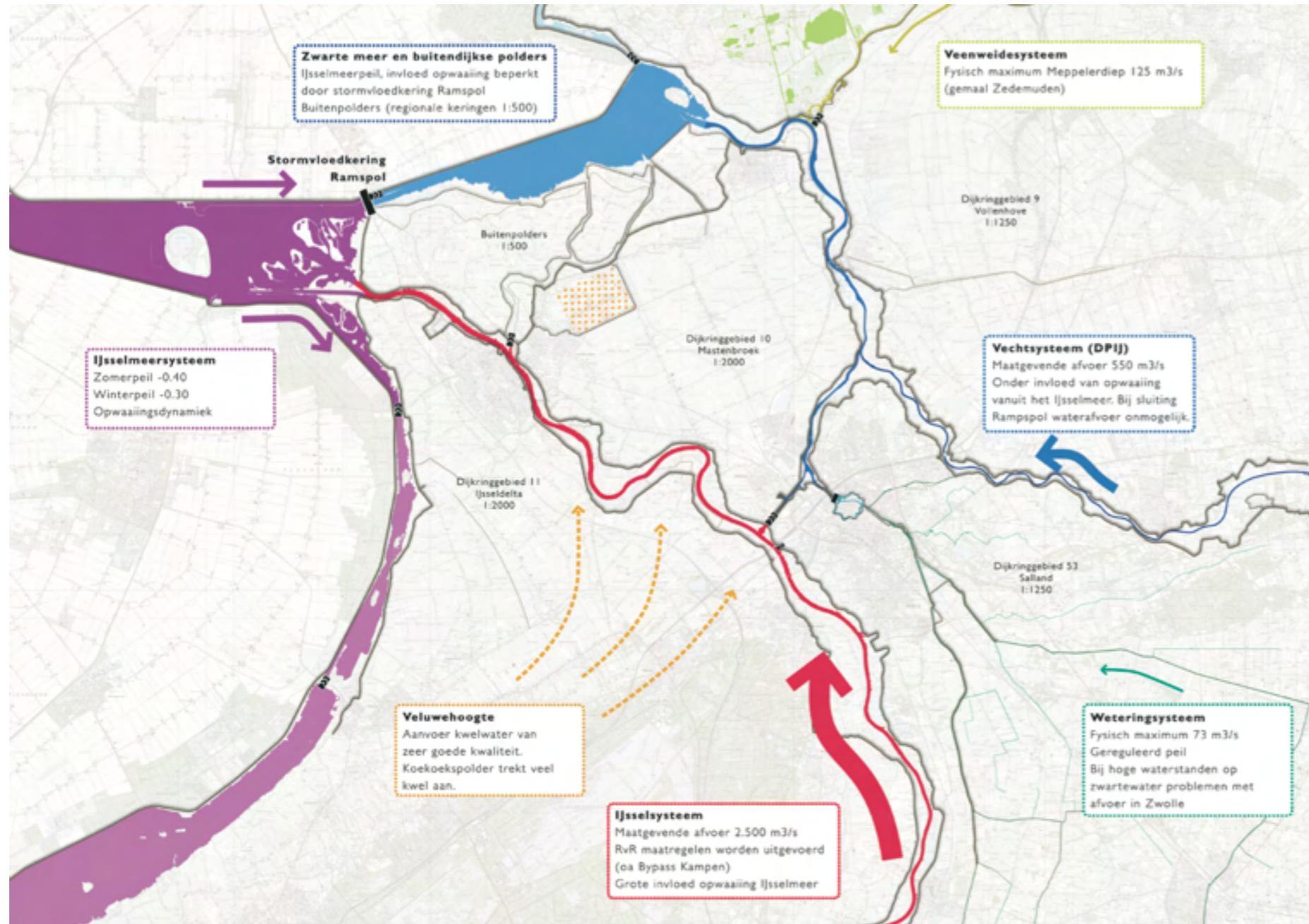


LTP IJssel Vecht Delta (2013) (door: H+N+S Landschapsarchitecten, Bureau Buiten, De Beuk, Atelier 2t); in co-creation with municipalities, province and all relevant other stakeholders



Long Term Planning 'IJssel-Vecht'-delta

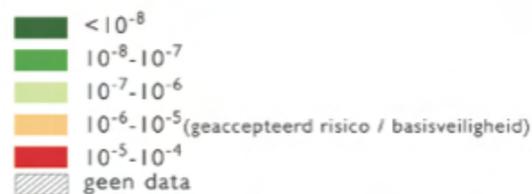
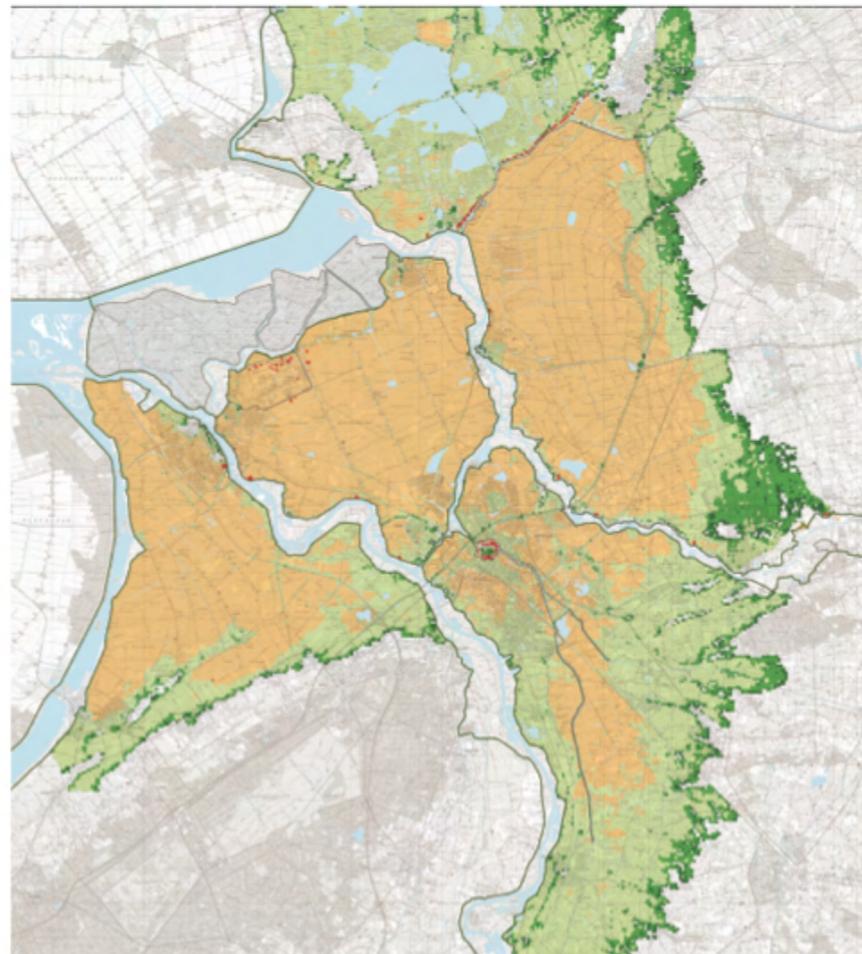
SAD started from the (coming) water tasks ...



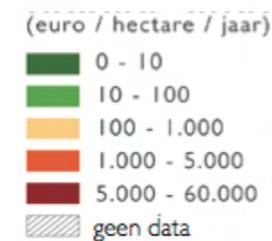
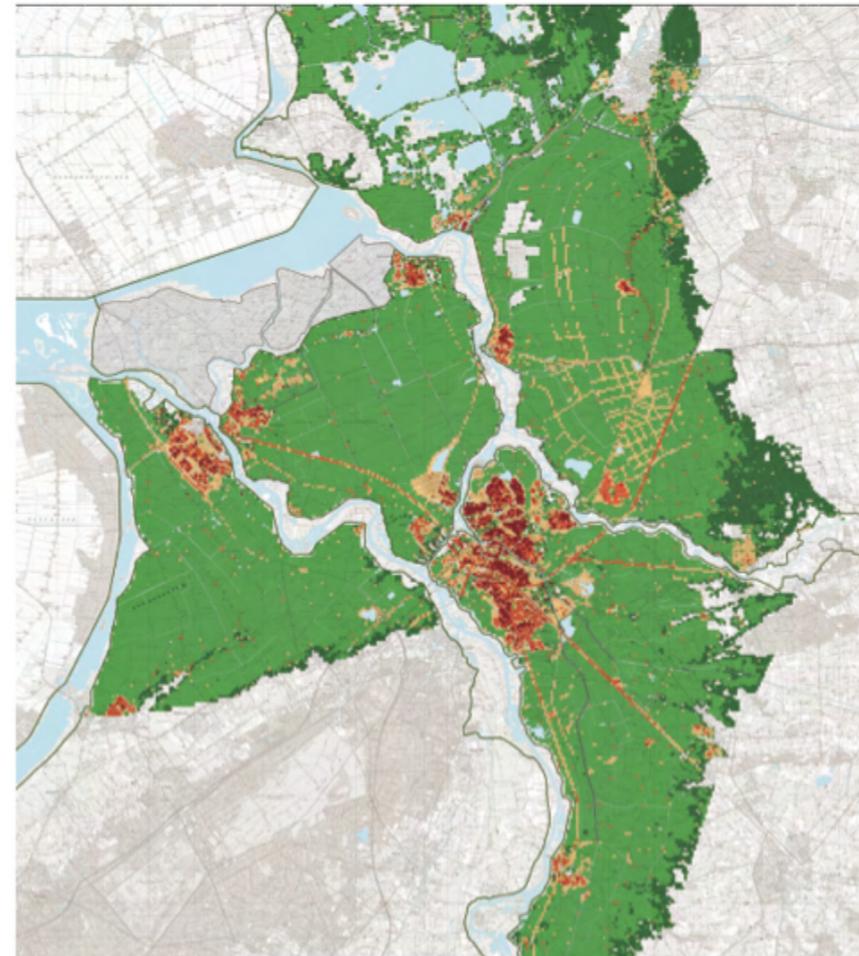
Long Term Planning 'IJssel-Vecht'-delta

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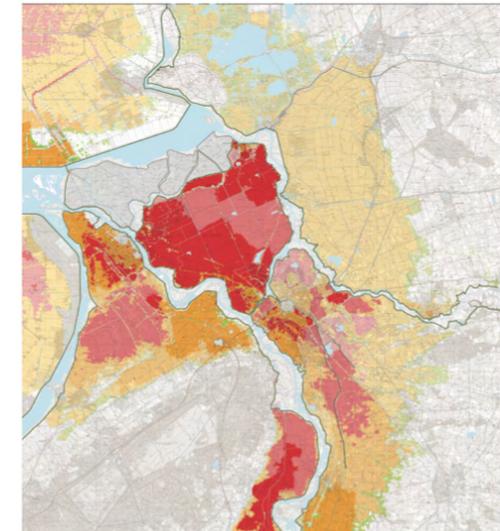
Local individual risk



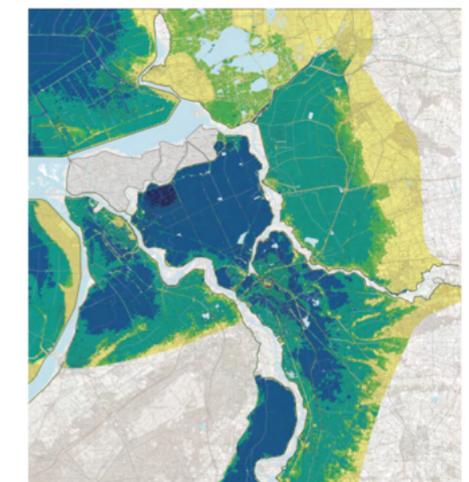
Expected economical damage



Blootstelling

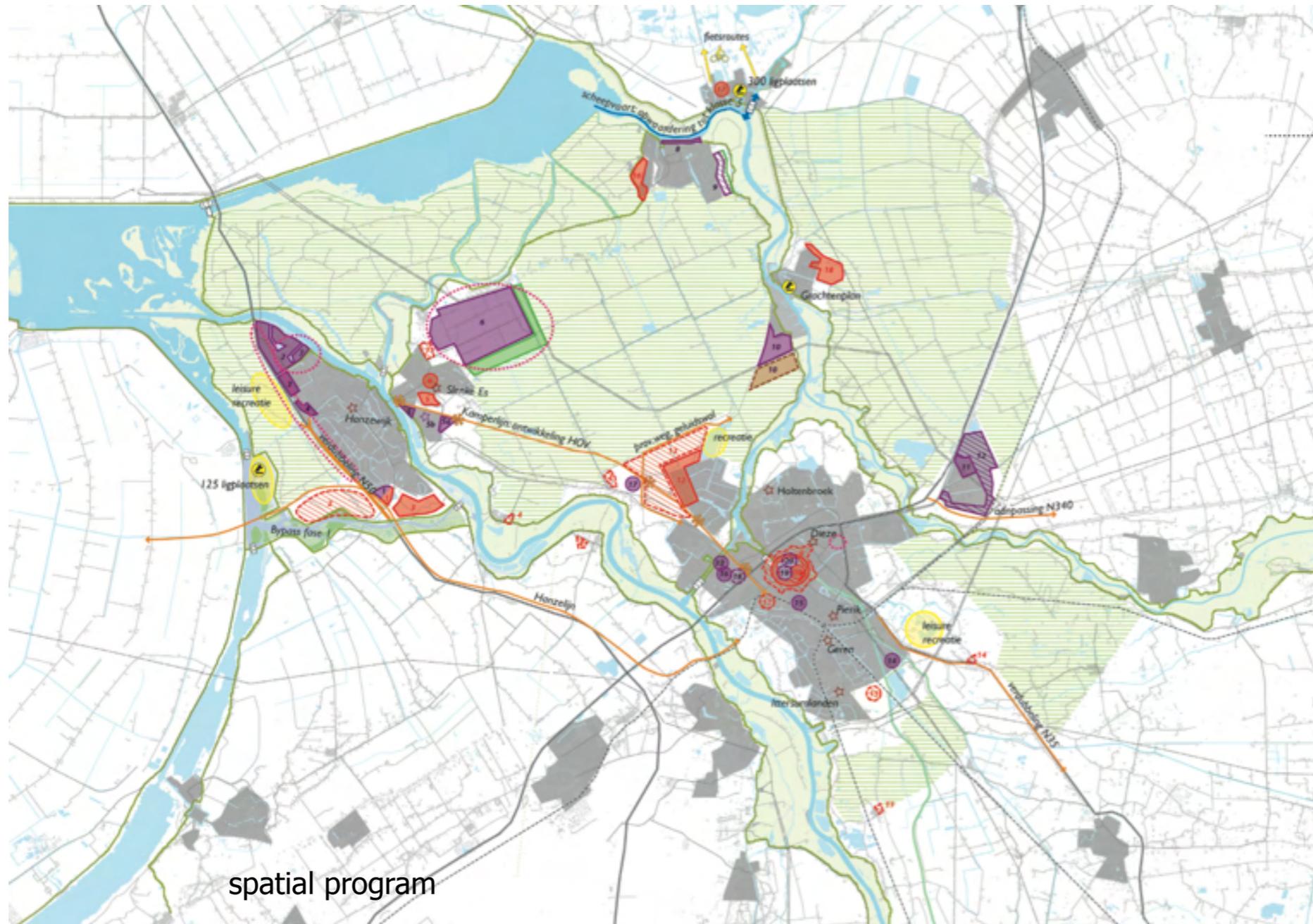


Maximale overstromingsdiepte

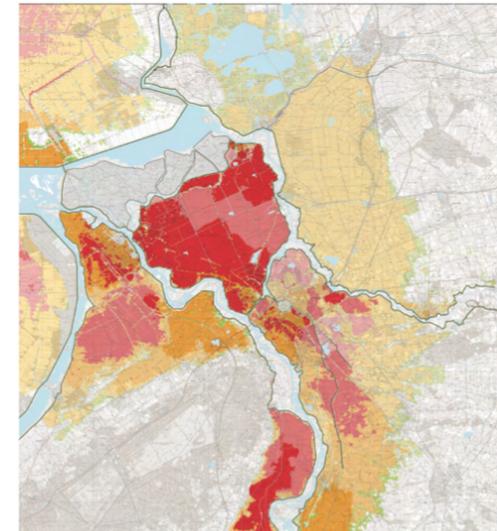


Long Term Planning 'IJssel-Vecht'-delta

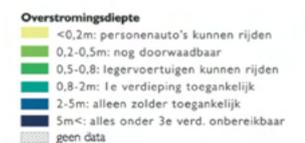
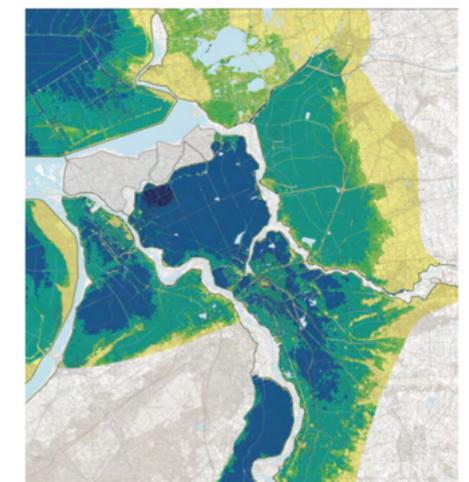
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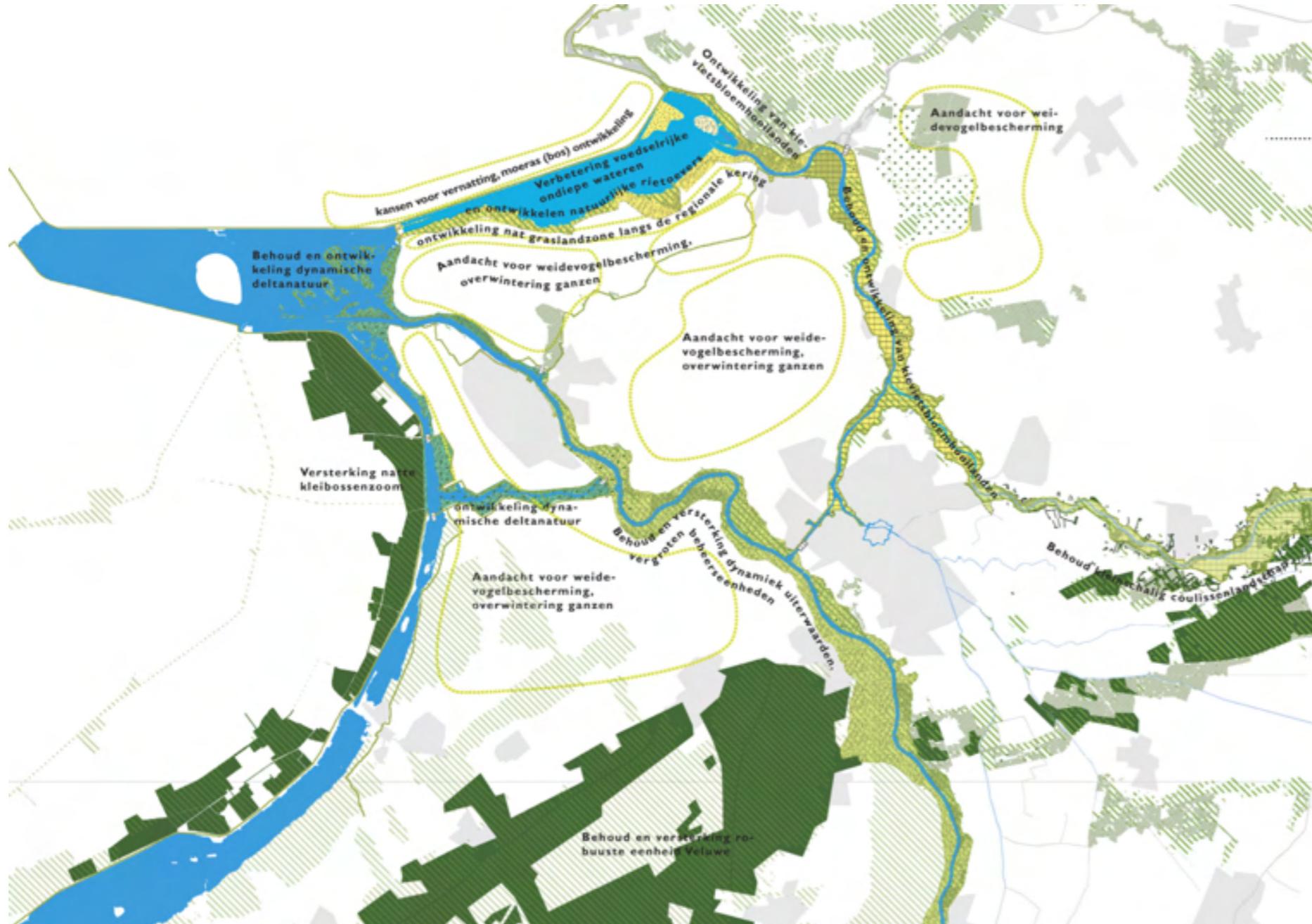


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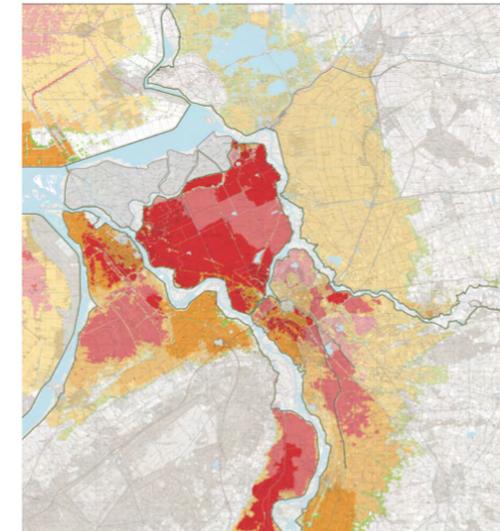


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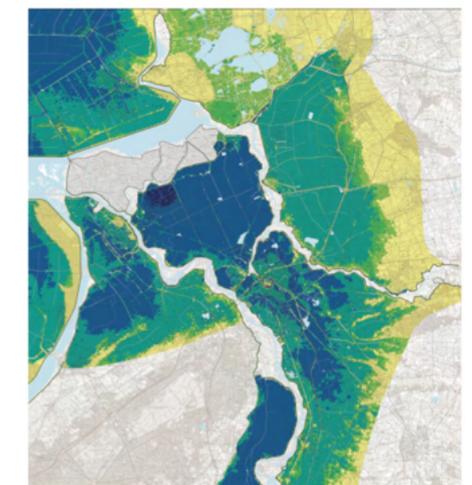
SAD started from the (coming) water tasks ...



Blootstelling



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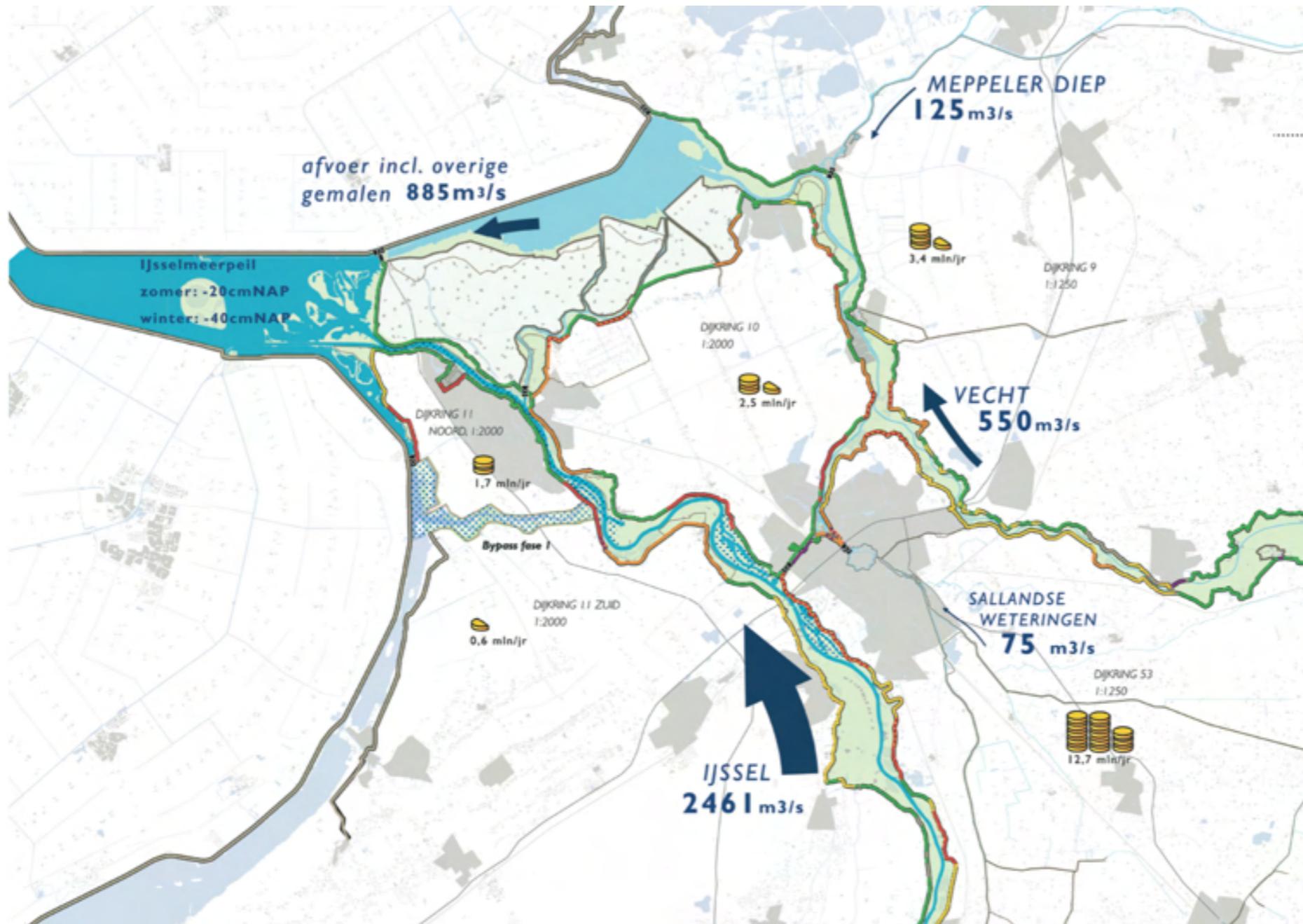


Overstromingsdiepte

ecological ambitions

Long Term Planning 'IJssel-Vecht'delta

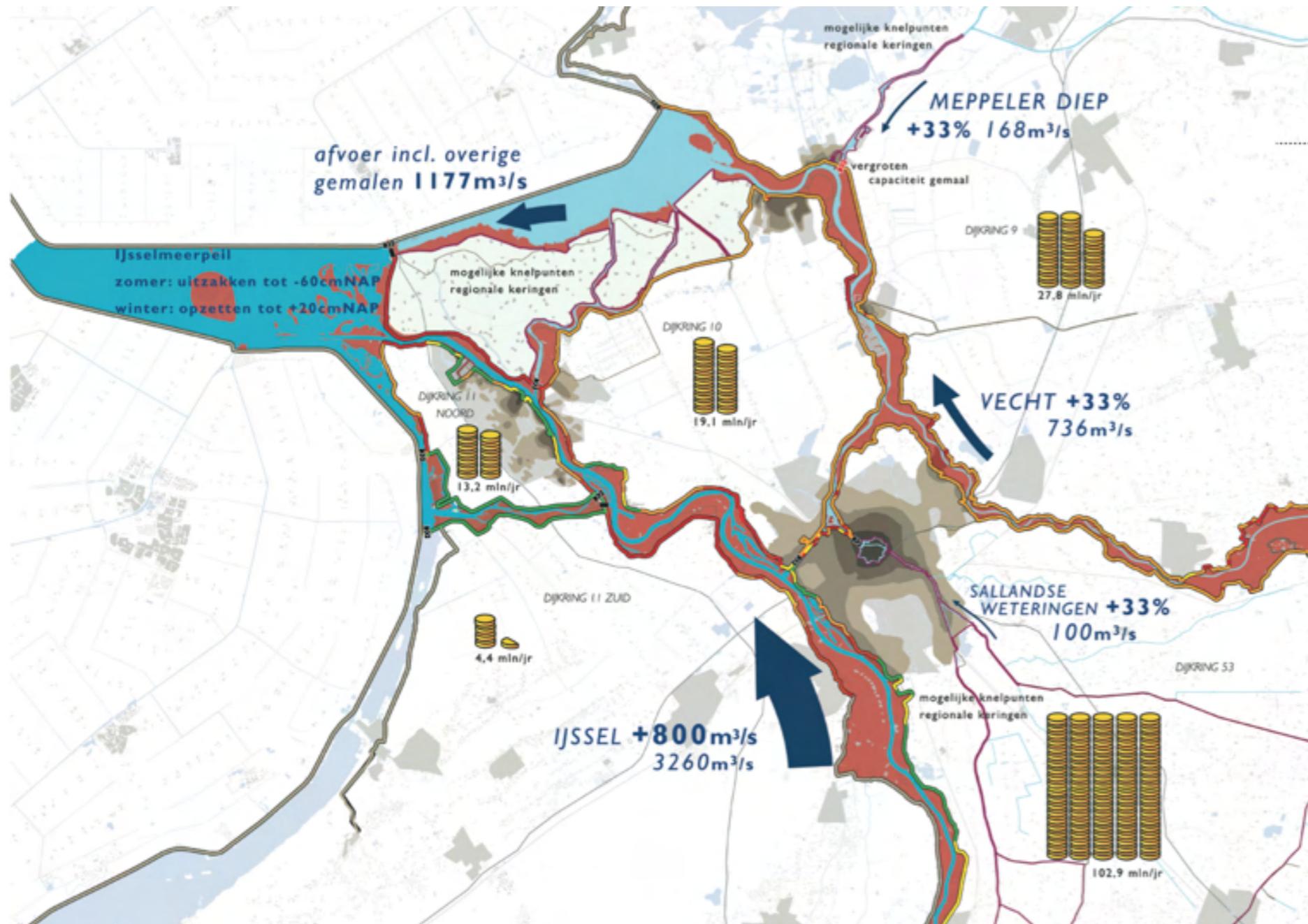
SAD started from the (coming) water adaptation tasks ...



existing
high-tide 'tasks'

Long Term Planning 'IJssel-Vecht'delta

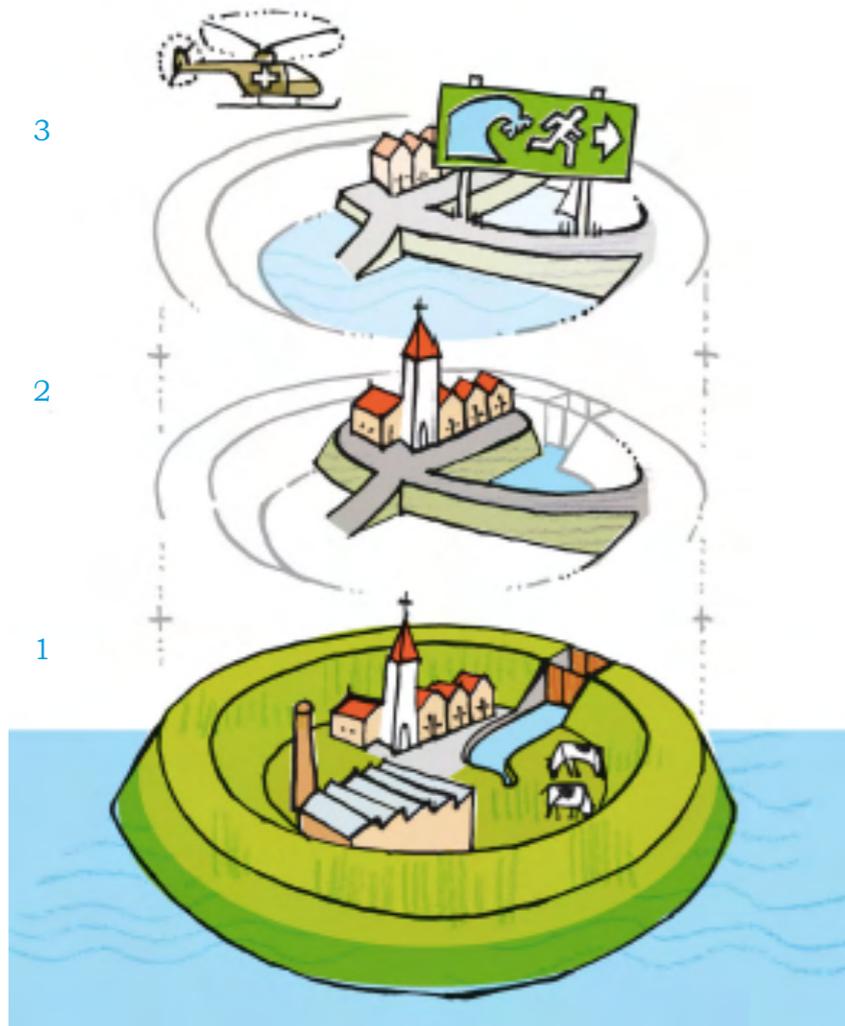
SAD started from the (coming) water adaptation tasks ...



extreme (2100-)
high-tide 'tasks'

Long Term Planning 'IJssel-Vecht'delta

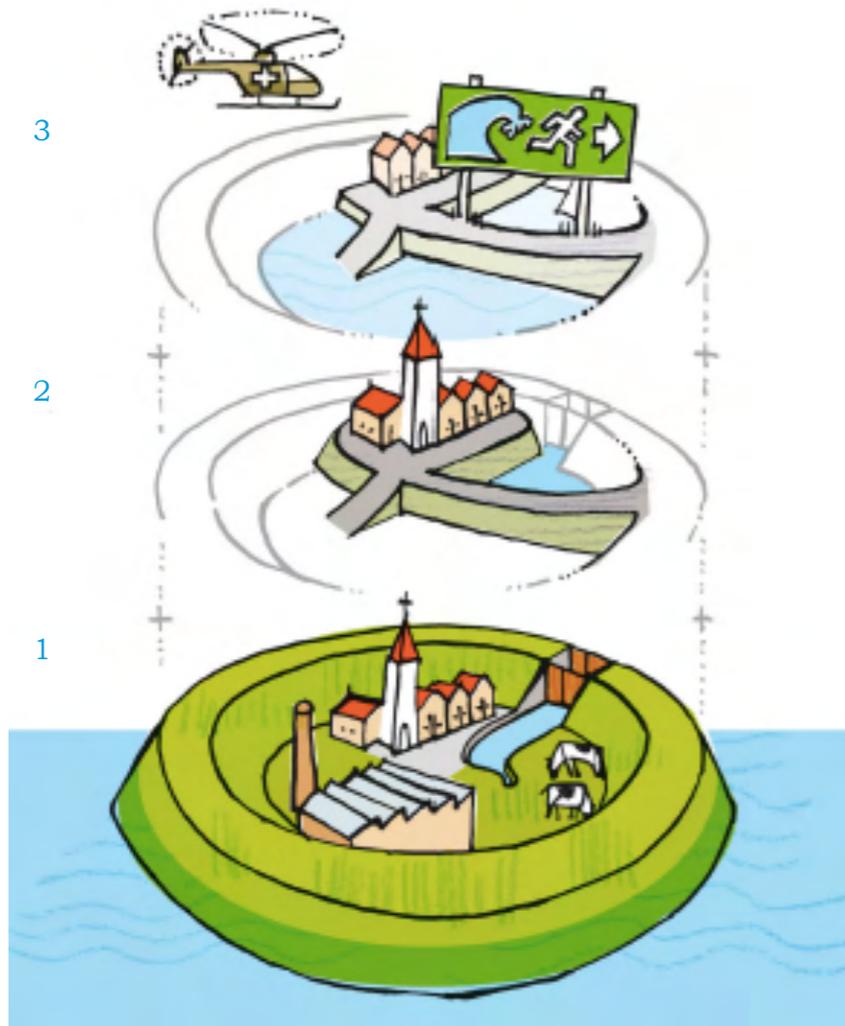
spatial- & water tasks, and multi layered safety



Long Term Planning 'IJssel-Vecht'delta

spatial- & water tasks, and multi layered safety

2nd layer: promising for (IJssel-Vecht)delta (IJVD) plays an important role in the Deltaprogramma (DP2014)



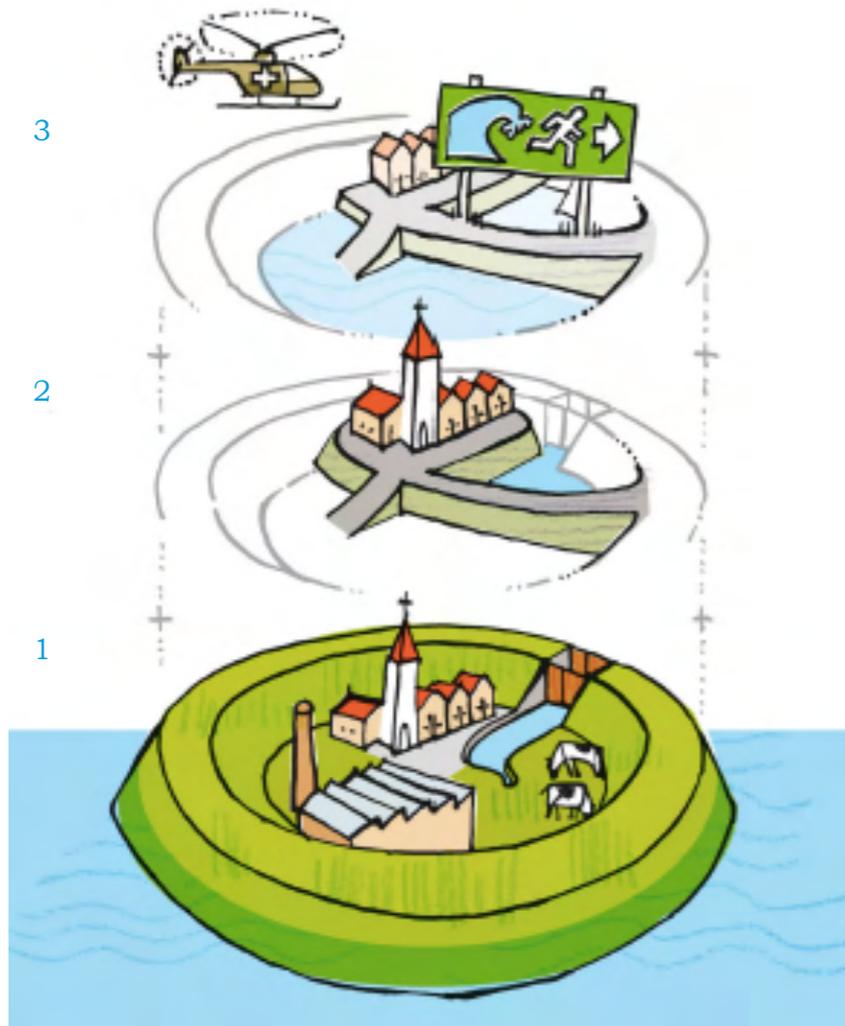
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spatial- & water tasks, and multi layered safety

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Strategy 1

First layer (prevention) most important. Additionally measures are provide regarding layer 2 (spatial lay-out) and layer 3 (disaster management)



Long Term Planning 'IJssel-Vecht'delta

spatial- & water tasks, and multi layered safety

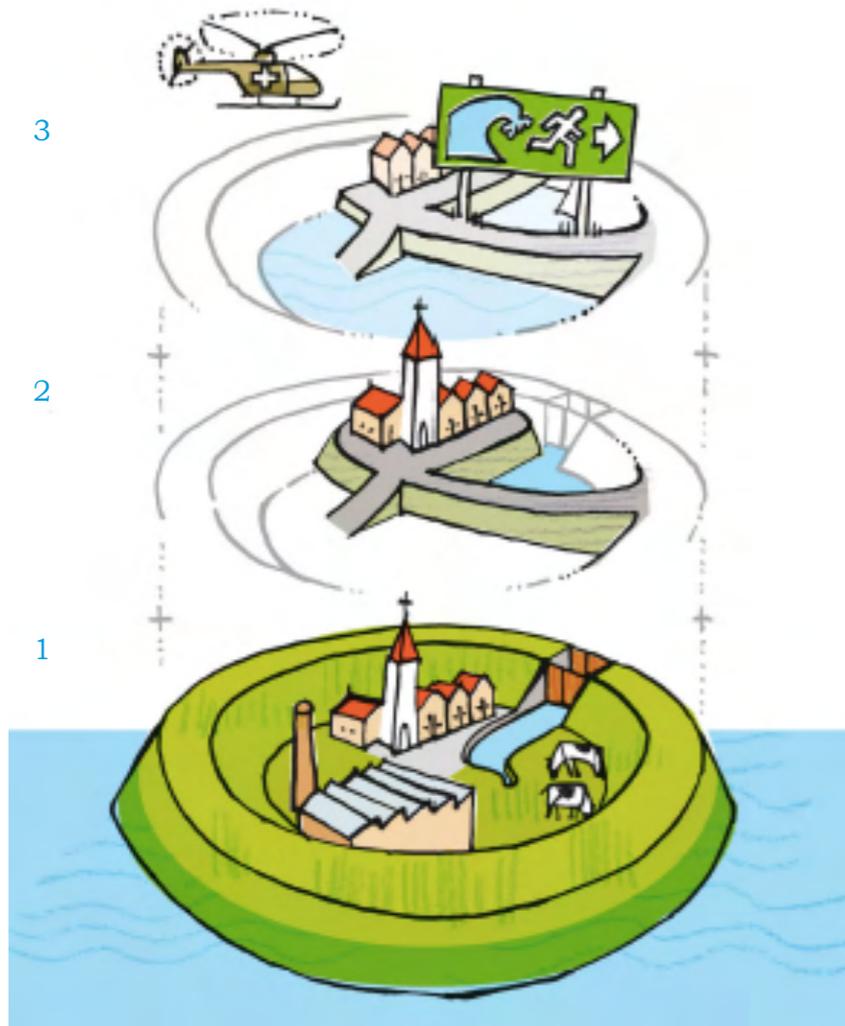
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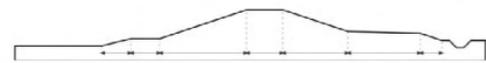
Strategy 2

Measures in the three MLS layers are exchangeable
Per sub-area most promising ratio regarding the measurements are chosen and elaborated.



Long Term Planning 'IJssel-Vecht'delta

'matching' of spatial- and adaptation tasks ...



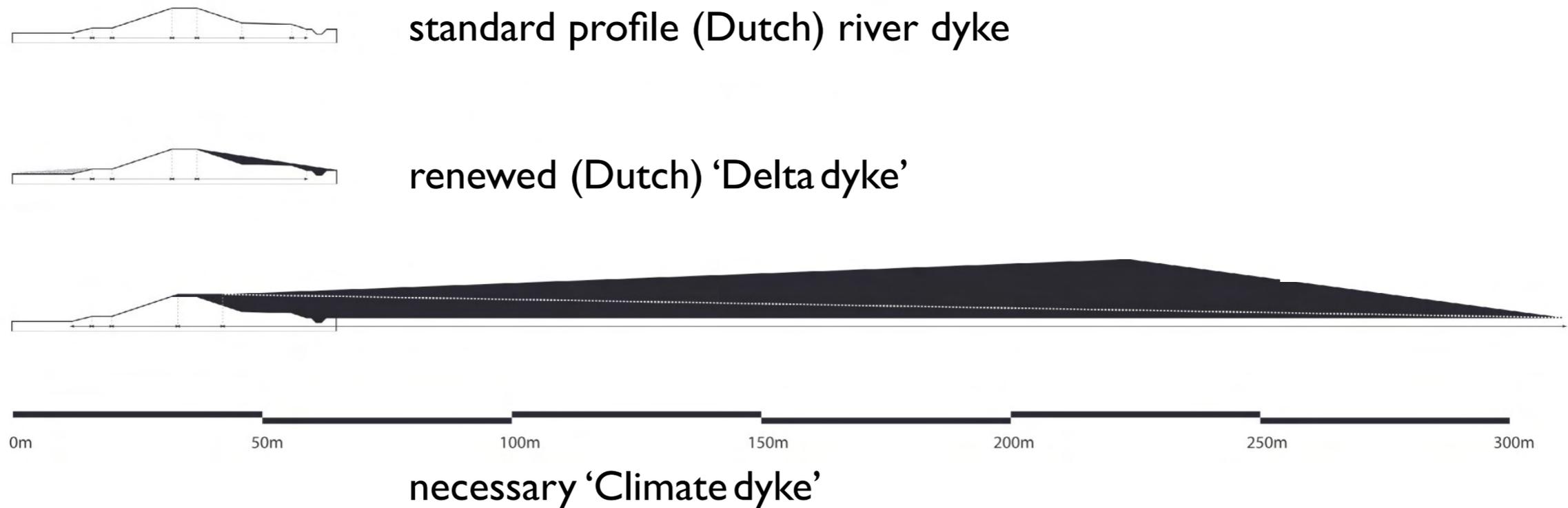
standard profile (Dutch) river dyke



renewed (Dutch) 'Delta dyke'

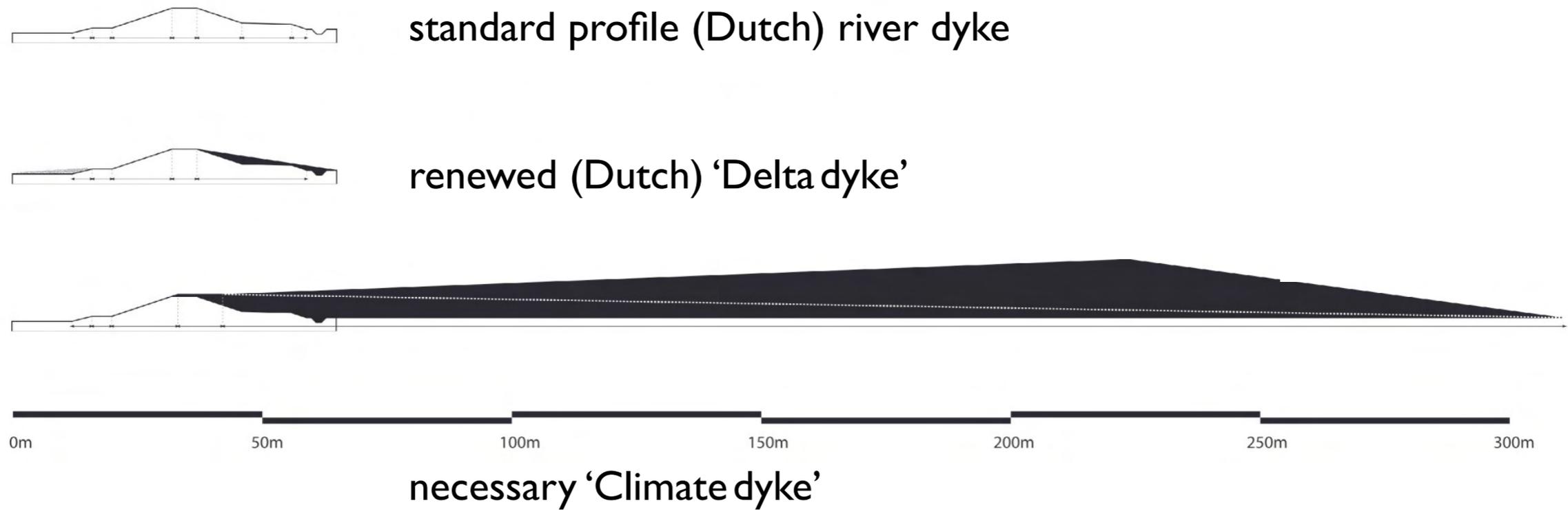
Long Term Planning 'IJssel-Vecht'delta

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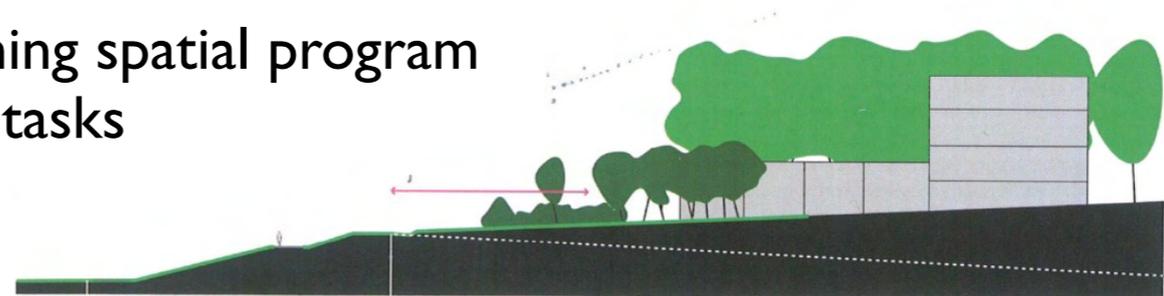


Long Term Planning 'IJssel-Vecht'delta

'matching' of spatial- and adaptation tasks ...



example of matching spatial program
water adaptation tasks
'Climate dyke'



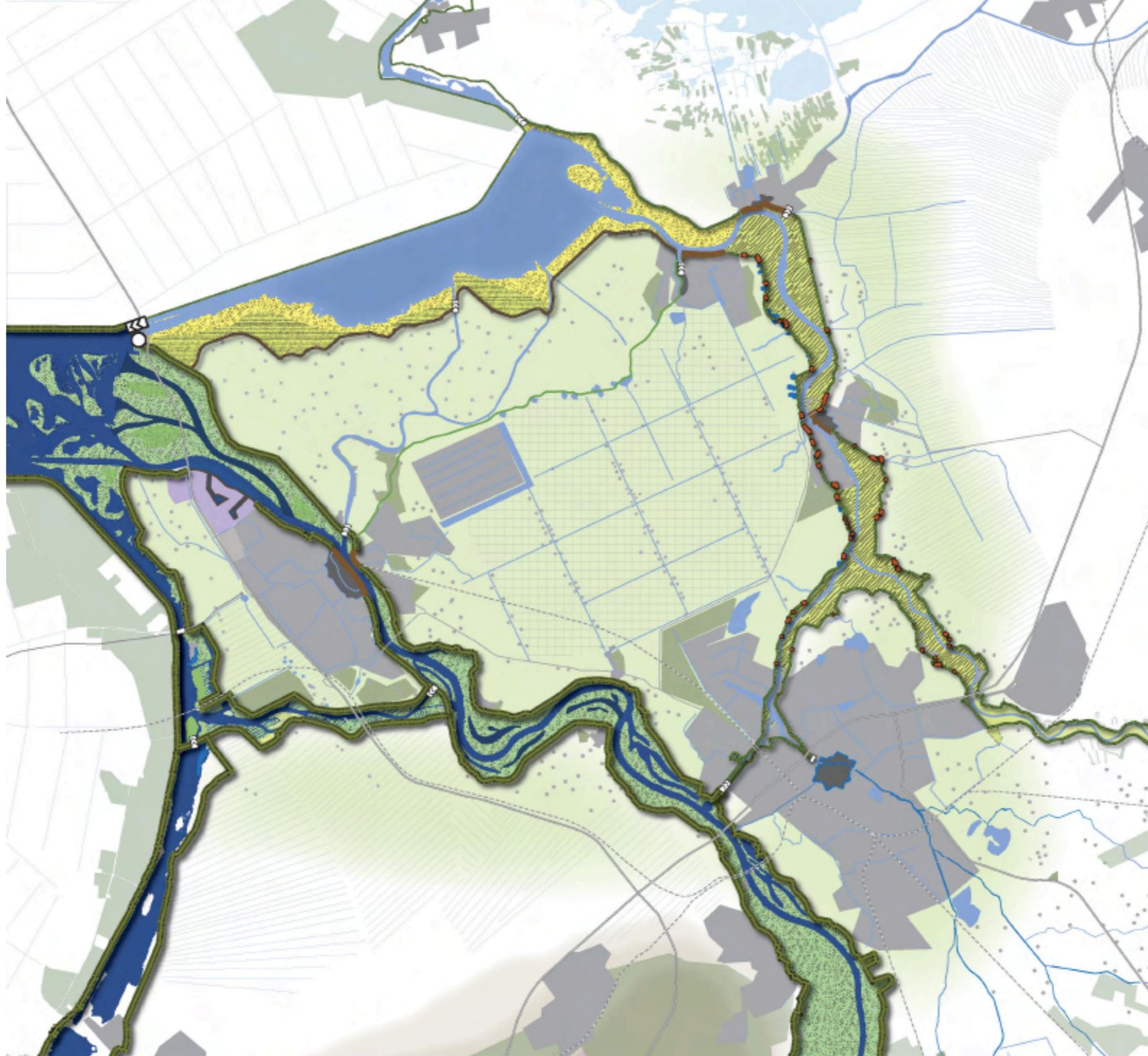
The IJssel-Vecht Delta in 3 Dimensions

scenario 'Preventie Voorop' (Prevention First)

- Prevention policy: **avoiding of flooding paramount.**
- There is **no differentiation between city and hinterland.**
- **Dykes** concern for the entire area the first pillar of the safety policy.
- Further separation IJssel- and Vechtsystem: in time fixed sluice with pumps at 'Ramspol'.
- 'Zwarte Meer' becomes 'nested water system' with a more regulated level, **optimal conditions for reedbeds and piping.**
- Sparing cultural-historical valuable dykes/waterfronts 'Zwarte Water'.
- Along the IJssel measurements in line with '**ruimte voor de rivier**'.
- Upstream measurements to avoid nuisance near 'Sallandse Weteringen'.

Prevention First

LTP IJssel Vecht Delta (2013)
(door: H+N+S Landschapsarchitecten,
Bureau Buiten, De Beuk, Atelier 2t)



LEGENDA

Ijsselsysteem

- water (o.i.v. opwaaiings- en afvoerdynamiek)
- primaire keringen
- RvR+ maatregelen
- dynamische natuur: riet en graslanden
- verweving stad en land
- doorontwikkeling zuiderzeehaven

Vechtsysteem

- water (gereguleerd peil)
- consolidatie keringen
- nieuwe primaire kering Kampereilanden
- keersluis en pomp
- Rampspol
- rietlanden
- natte graslanden
- kievietsbloem hooilanden
- consolidatie waterfronten
- verweving stad en land
- historische dijkbebouwing

- ### Polder Mastenbroek
- waterboeren

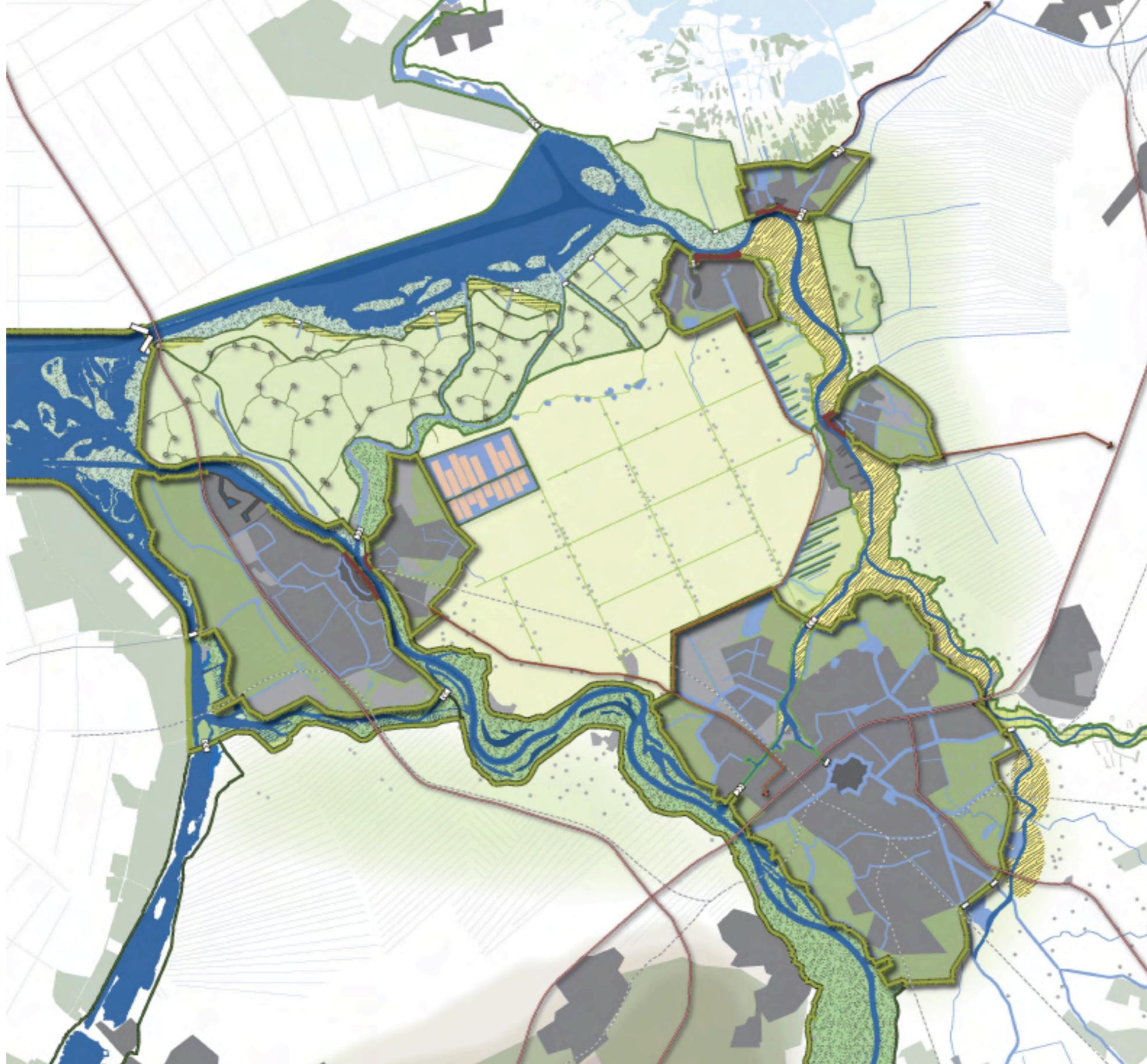
The IJssel-Vecht Delta in 3 Dimensions

scenario 'Mix op Maat' (Customised -Mix)

- For each sub-area will be investigated which **mix of measurements** in the 3 layers of Multi Layer Safety approach fits: **differentiation between city and hinterland**.
- Urban area: prevention by providing robust dyke rings. Urban islands in the dynamic delta. **Adaptive building** and **internal watersystem** with sufficient storage.
- Rural areas: mix of measurements in especially 2nd and 3rd layer.
- Conservation of a storm surgebarrier near 'Ramspol'.
- Drainage of river Vecht near barrier catched and stored in storage polders.
- Redirecting 'Sallandse Weteringen' southeast of 'Zwolle' towards river Vecht.
- Differentiation and specificity regarding development of ecologies & **nature** (choices).

Customised -Mix

LTP IJssel Vecht Delta (2013)
(door: H+N+S Landschapsarchitecten,
Bureau Buiten, De Beuk, Atelier 2t)



LEGENDA

IJssel- en Vechtsysteem

- water (o.i.v. opwaaiings- en afvoerdynamiek)
- RvR+ maatregelen
- dynamische natuur: riet en graslanden
- kievietsbloem hooilanden
- natte graslanden
- behoud balgstuw Ramspol

- Stedelijke eilanden
- stedelijke ringdijken, intern watersysteem robuuste waterfronten

Adaptieve ruimtelijke inrichting

- overslagbestendige dijkzones
- bergingspolders
- adaptief bouwen (terpen en verhoogde wegen)
- klimaatbestendige buitendijkse (haven)terreinen
- drijvende kassen Koekoekspolder
- infrastructurele maatregelen tbv evacuatie

The Sustainable Delta in 4 Dimensions

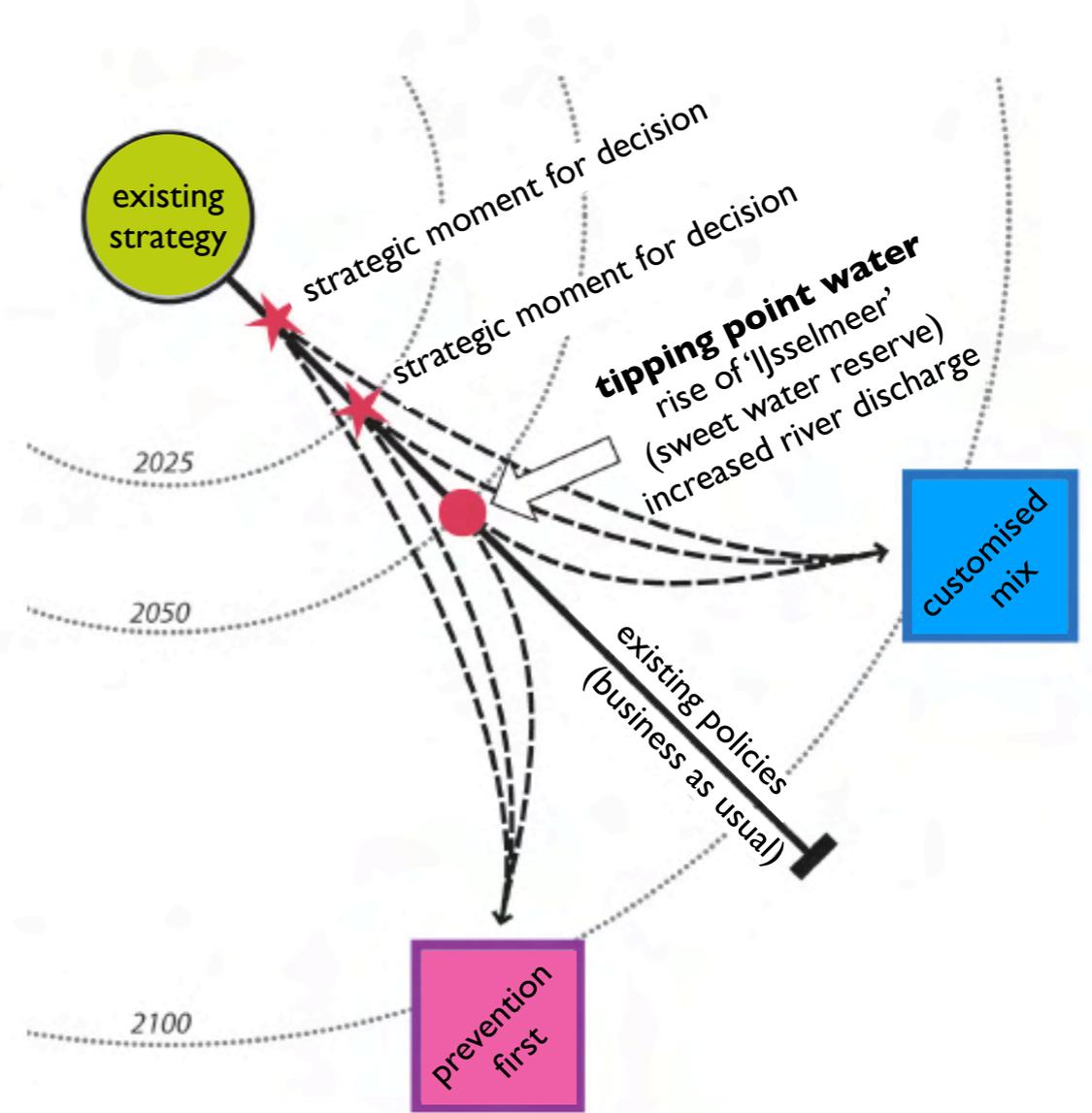
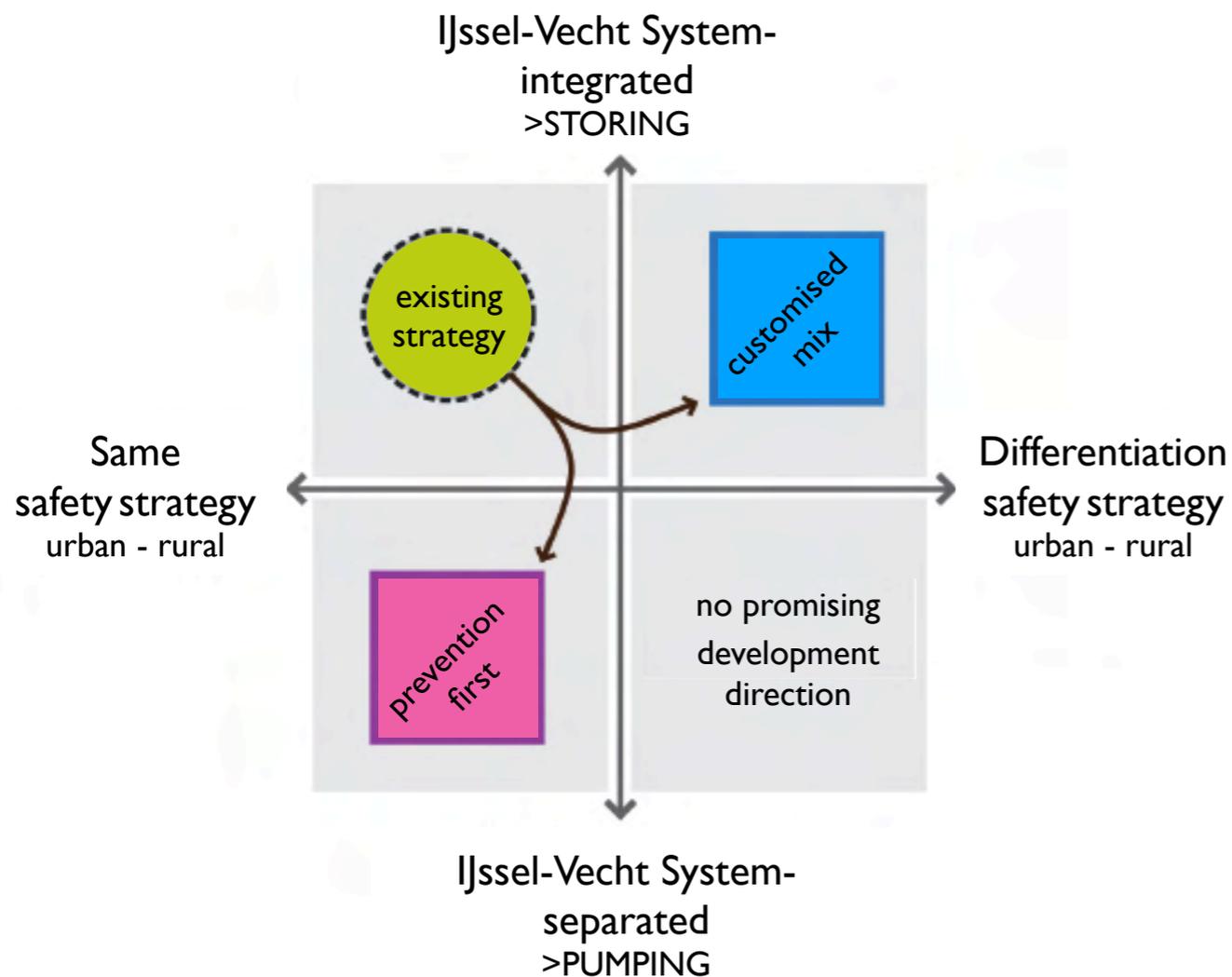
towards a real (permanent) sustainable IJV-delta

- Further focus on transformations of spatial quality; regarding the 3 ‘physical urban planning layers’: underground / networks / occupation
- In the IJssel-Vechtdelta translated towards ‘resilience’ and flexibility :
 - from (static) ordering towards (dynamic) control
 - from planed infill/arrangements towards development;
 - from (quantitative) program allocation towards (qualitative) planning of conditions;
 - from growth towards transformation; and
 - from spatial plan towards research by design and strategic interventions.

The Sustainable Delta in 4 Dimensions

what to do in short term with Long Term perspectives ?

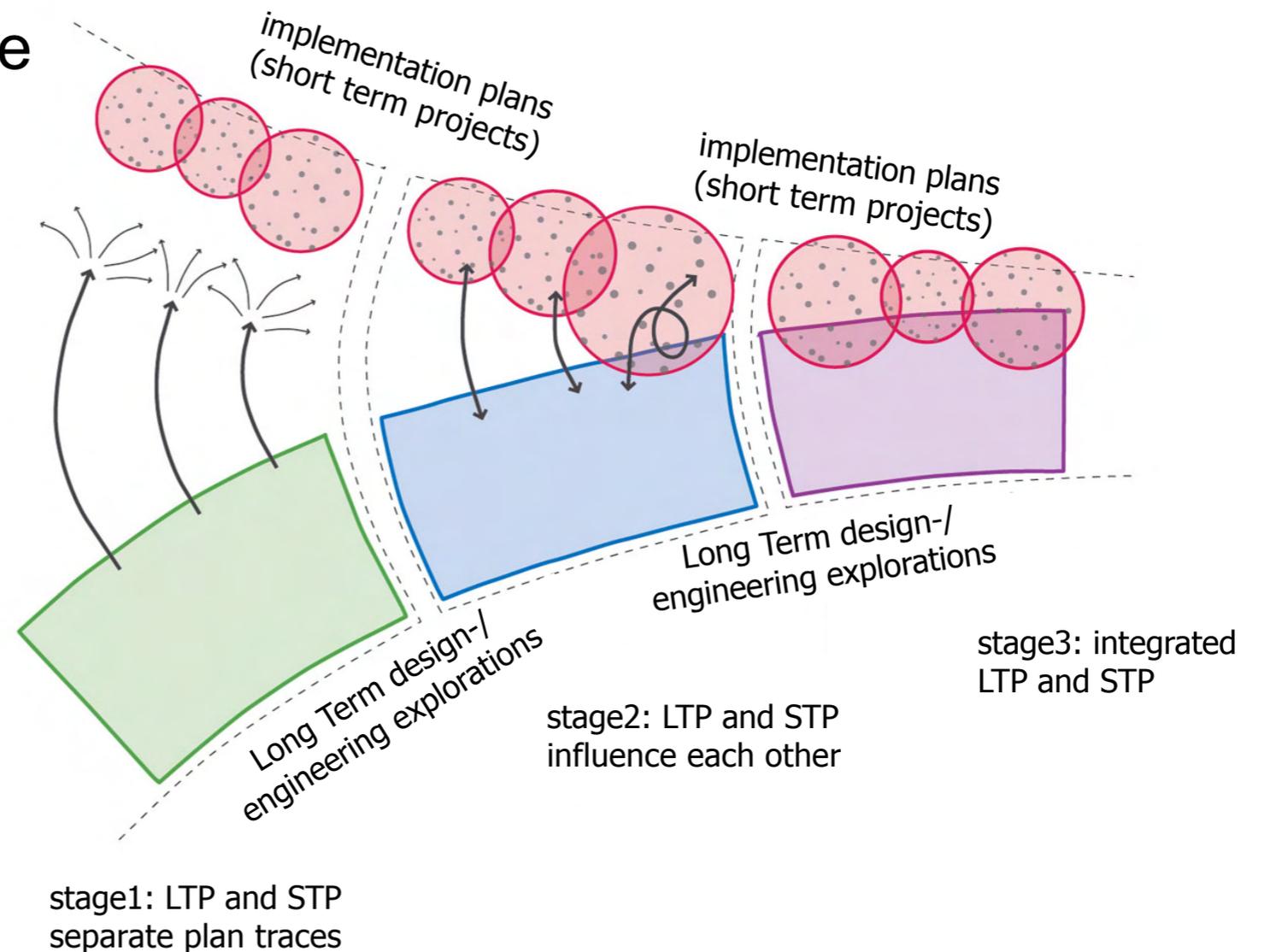
Insight in main choices and when these should/could be made:



The Sustainable Delta in 4 Dimensions

long- and short term ambitions related to LT perspectives ...

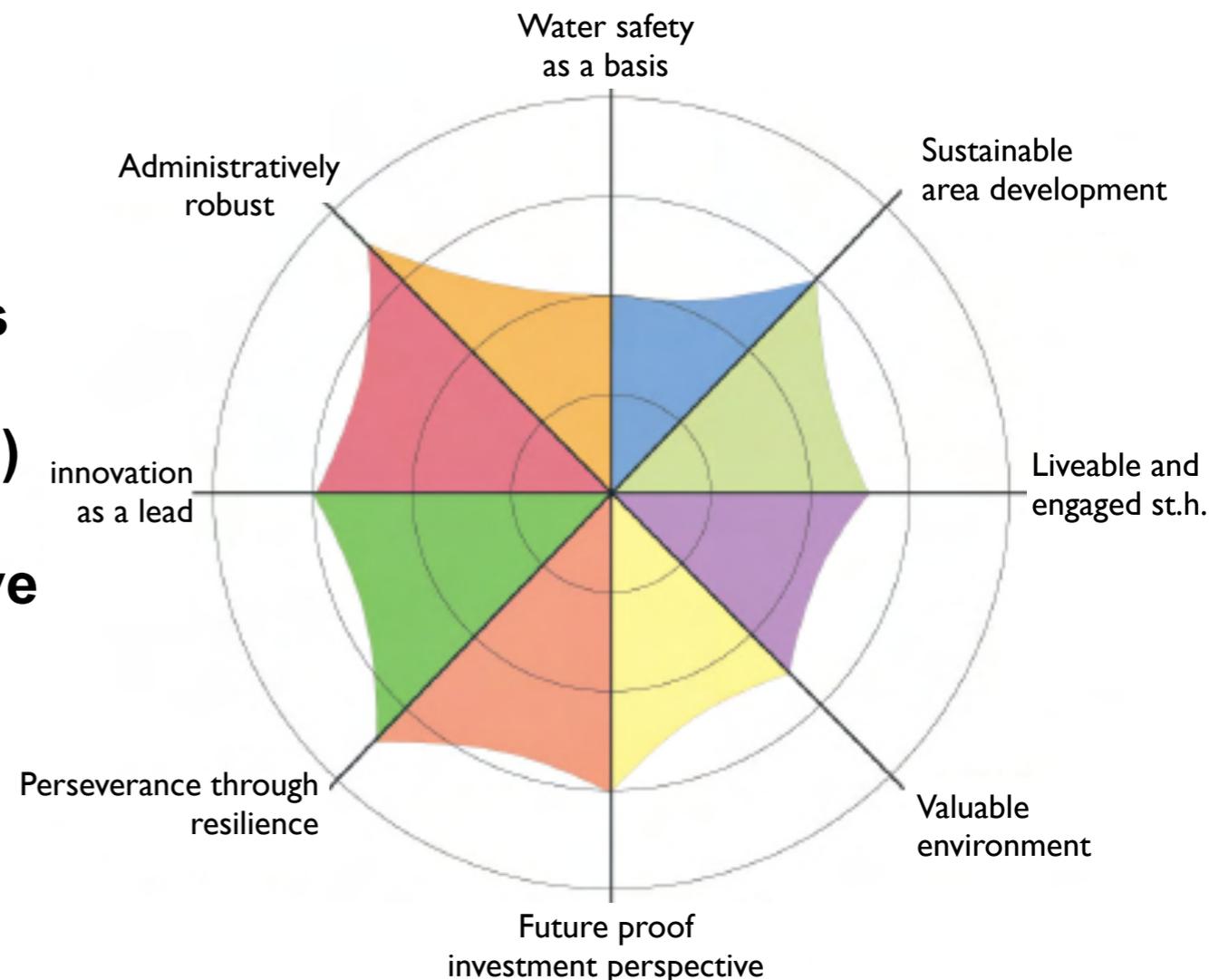
Three stages and how the short term and long term planning interact :



The Sustainable Delta in 4 Dimensions

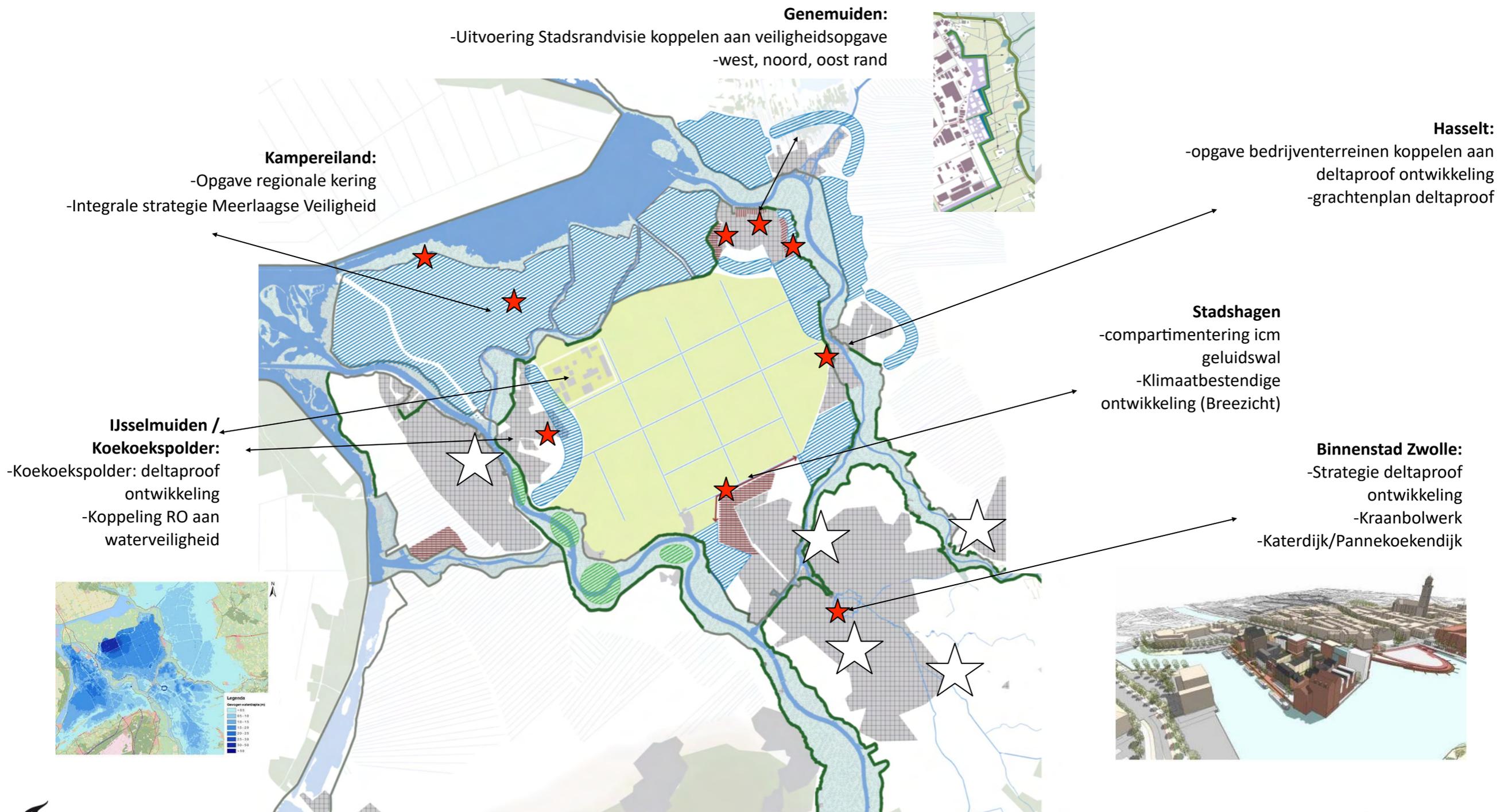
IJssel-Vechtdelta Principles (Specific, Measurable, Acceptable, Realistic and Time-bound)

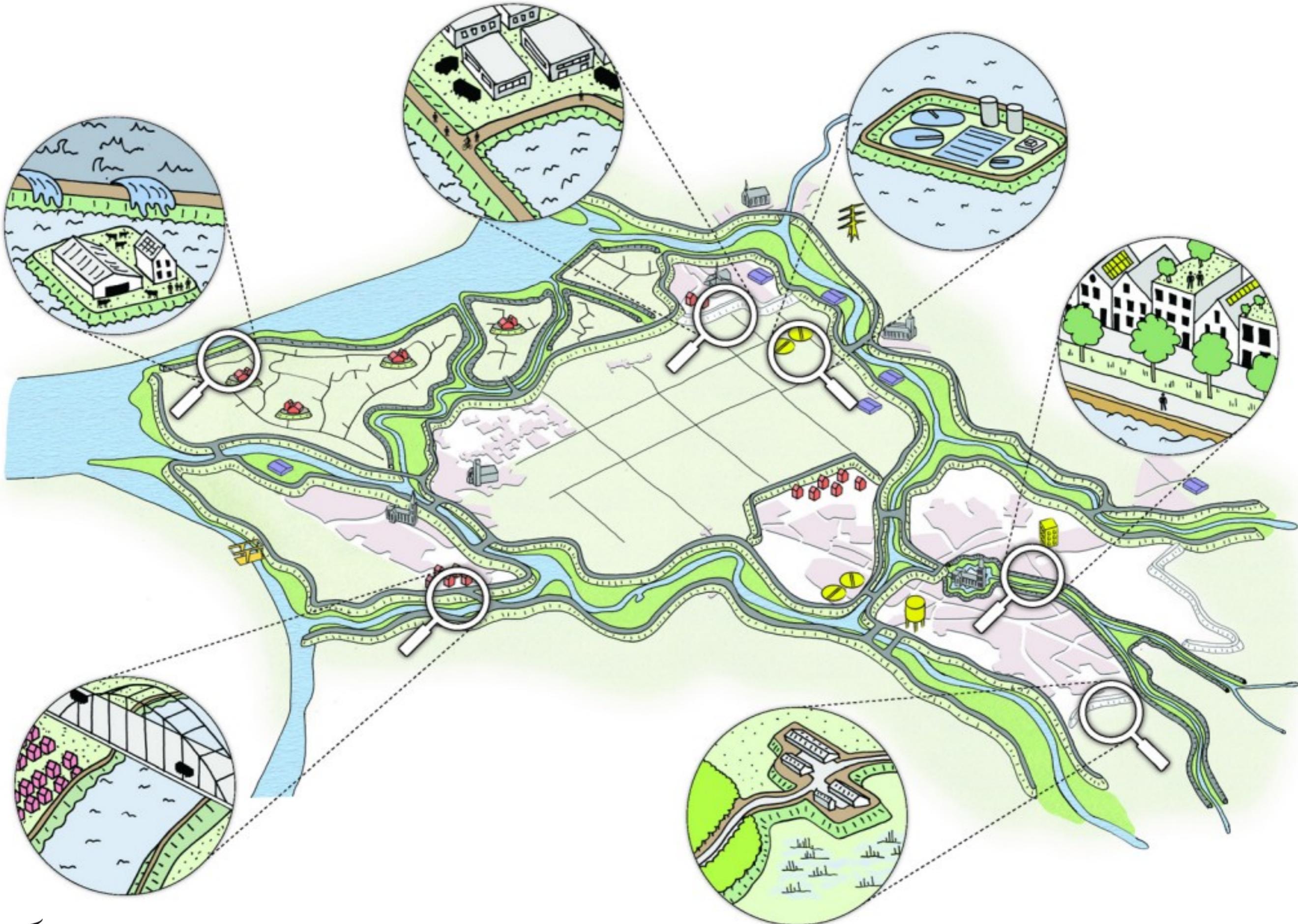
1. Water safety as a basis
2. Sustainable Area Development
3. Liveable and engaged stakeholders
4. Valuable environment (ecology/soil)
5. Future-proof investment perspective
6. Perseverance through resilience
7. Innovation as a lead / brand
8. Administratively robust



The Sustainable Delta in 4 Dimensions

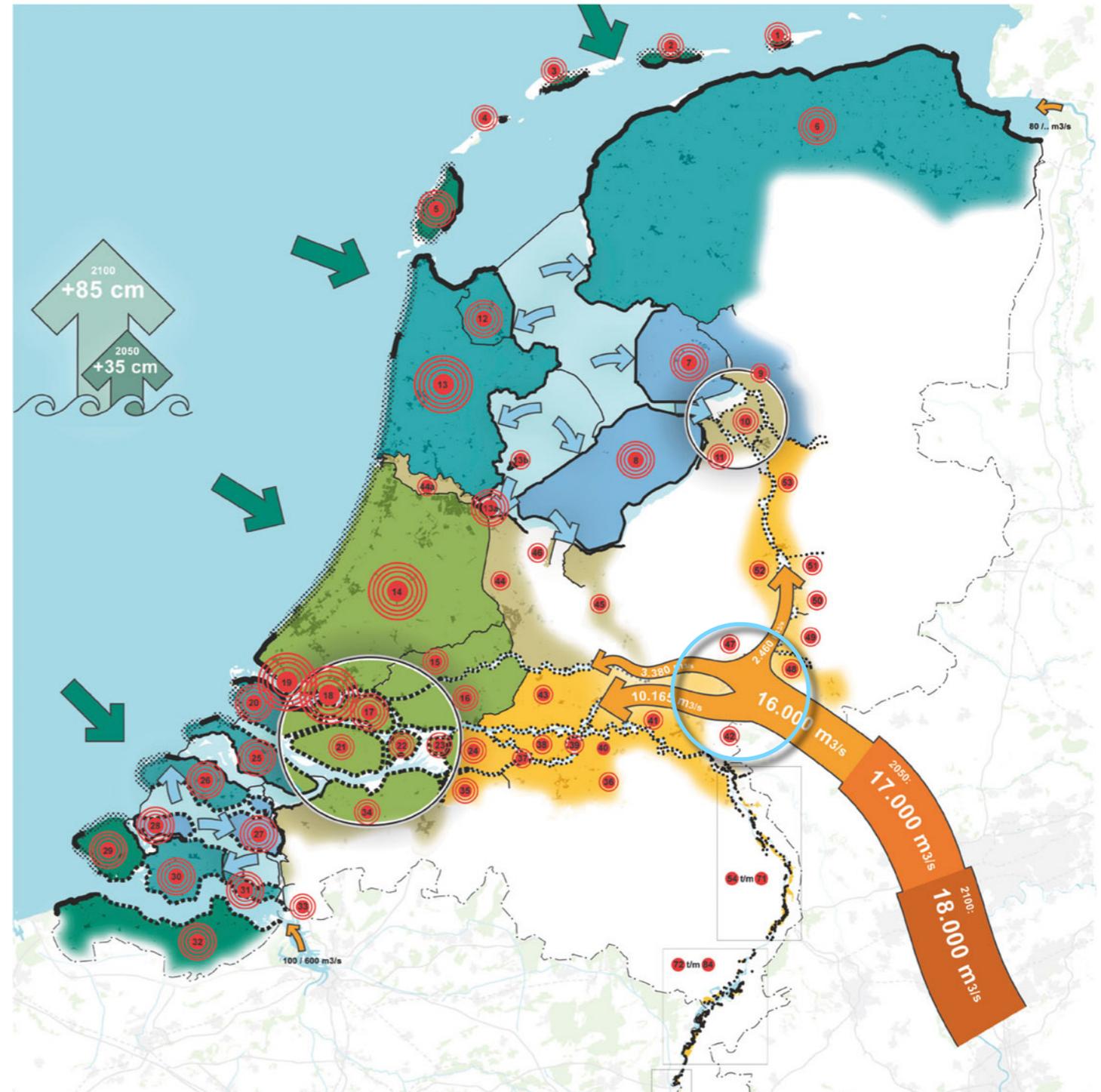
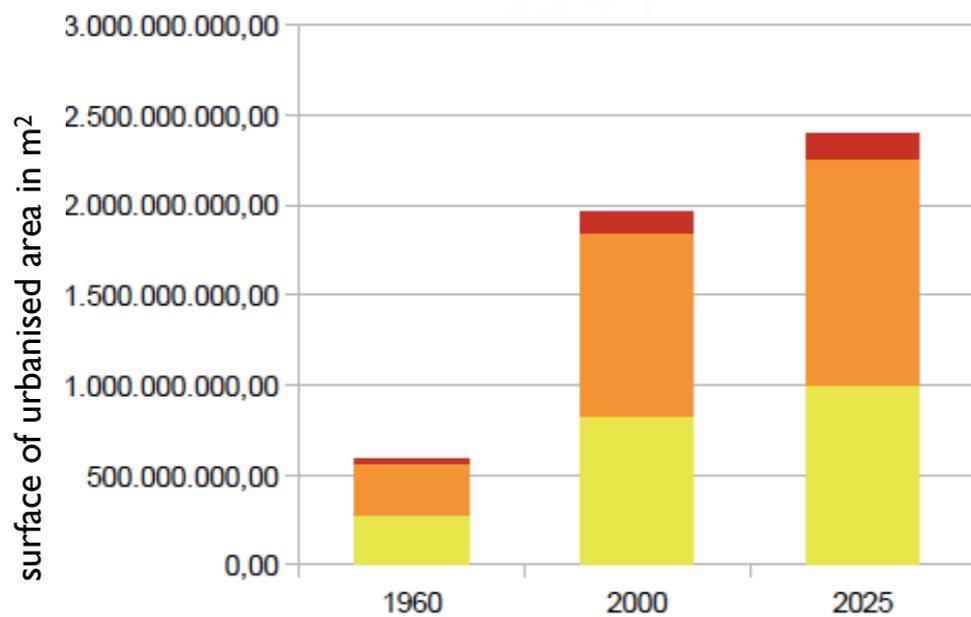
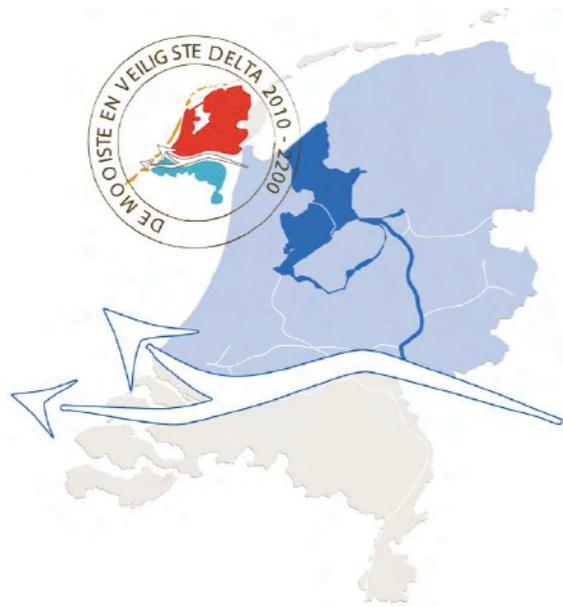
implementation program IJssel-Vechtdelta





courtesy: Urhahn Urban design & strategy

example of the LTP 'IJssel-Vecht'delta

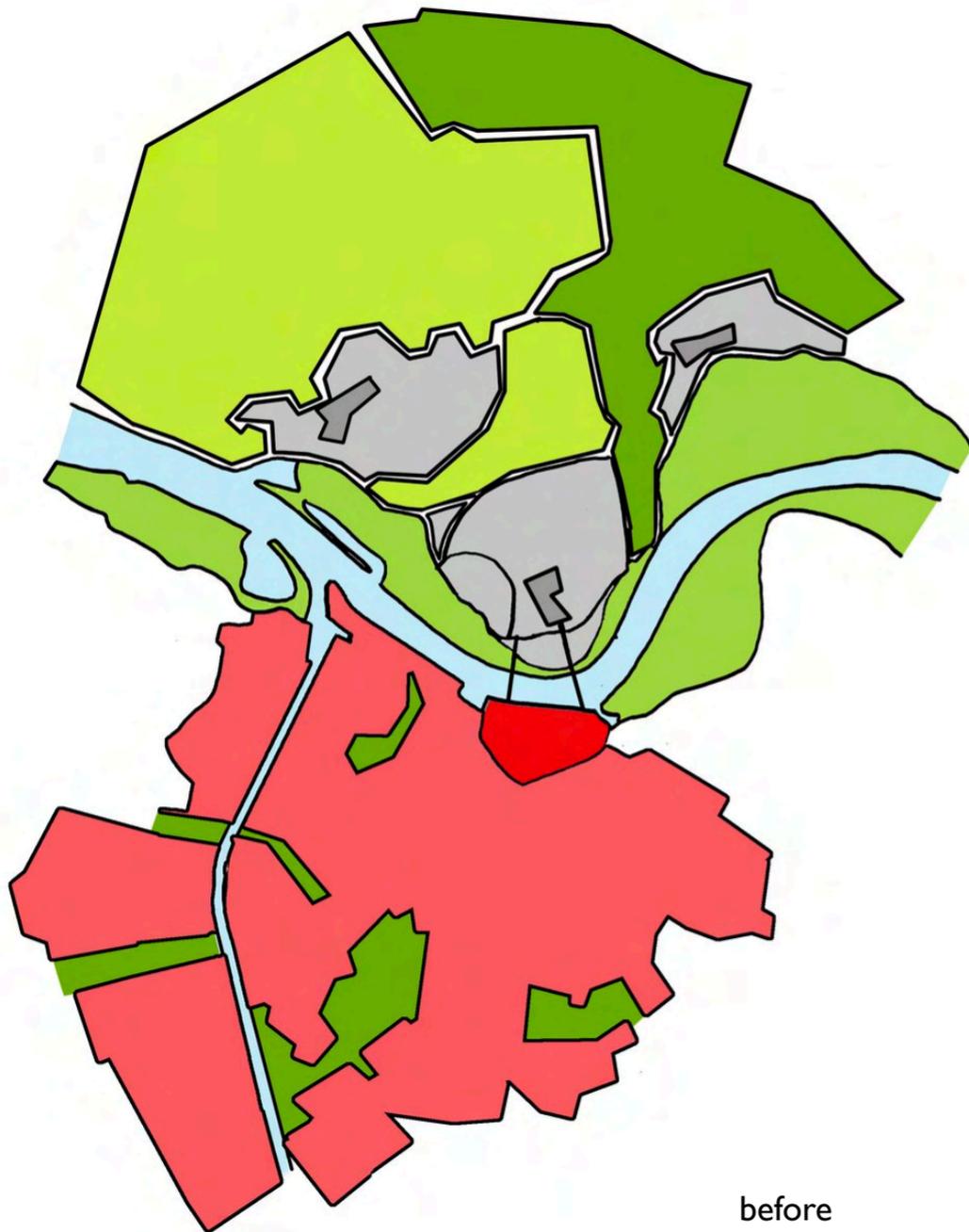


Nijmegen (NL); ‘Room for the River’ “Waal”

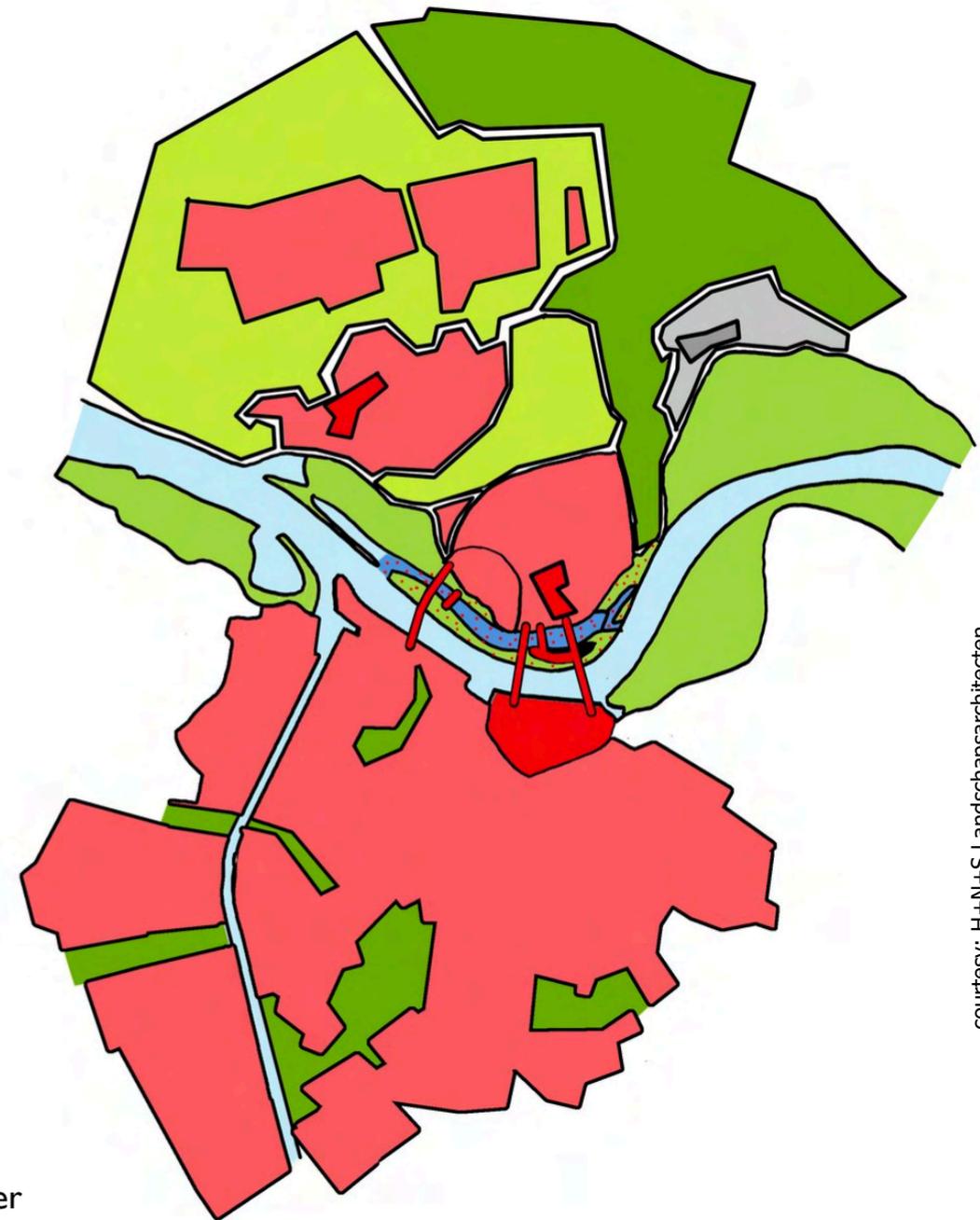


photo / copyright: Siebe Swart / Aeropicature

Nijmegen; 'Room for the River "Waal" '



before
(‘Wualsprong’ / Room for the River)



after
(‘Wualsprong’ / Room for the River)

courtesy: H+N+S Landschapsarchitecten



courtesy: H+N+S Landschapsarchitecten

Dutch National Room for the River program ; new secondary channel along narrowest part of the river "Waal" (near City of Nijmegen/Lent)

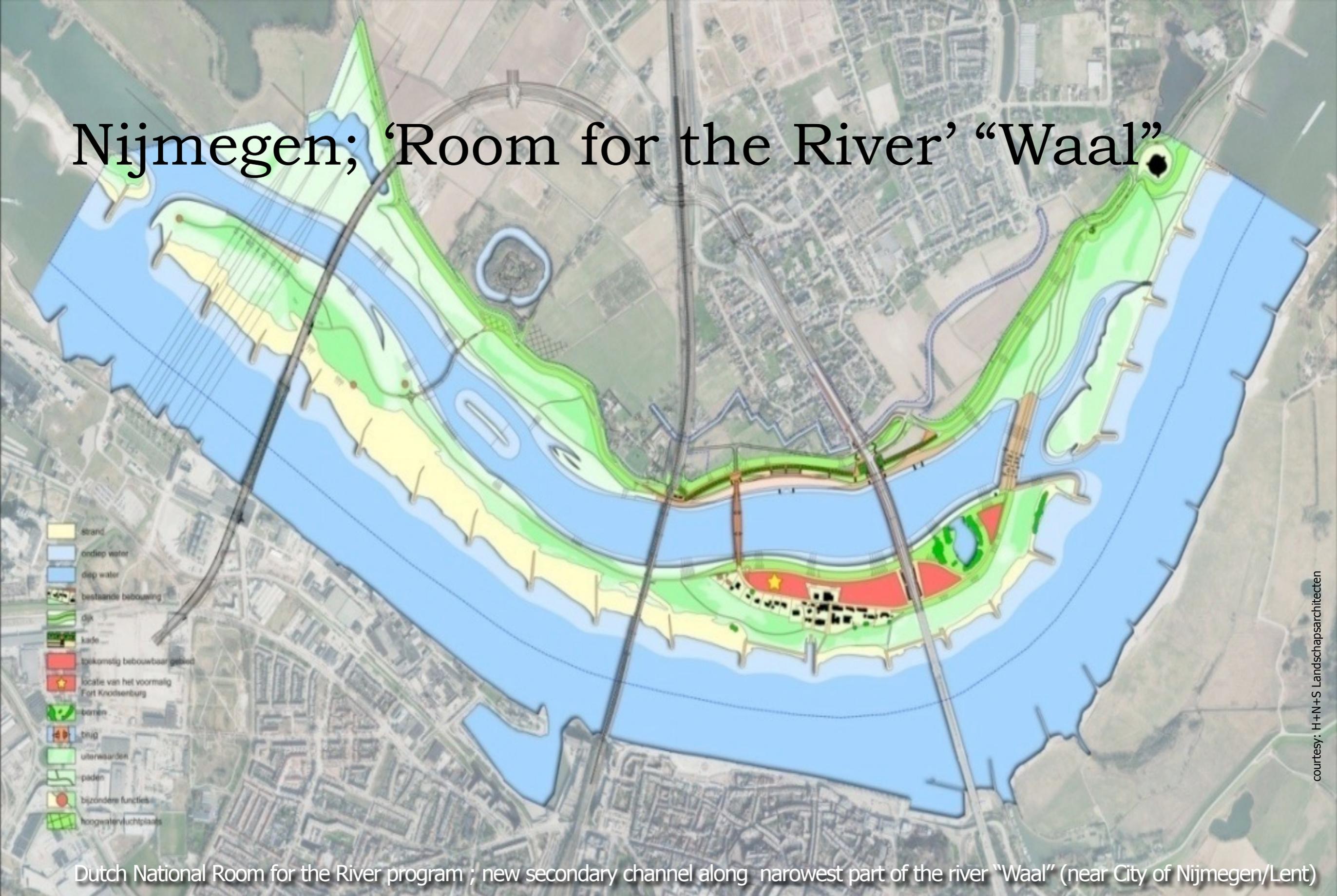
Nijmegen; ‘Room for the River’ “Waal”



courtesy: H+N+S Landschapsarchitecten

Dutch National Room for the River program ; new secondary channel along narrowest part of the river “Waal” (near City of Nijmegen/Lent)

Nijmegen; 'Room for the River' "Waal"



Dutch National Room for the River program ; new secondary channel along narrowest part of the river "Waal" (near City of Nijmegen/Lent)

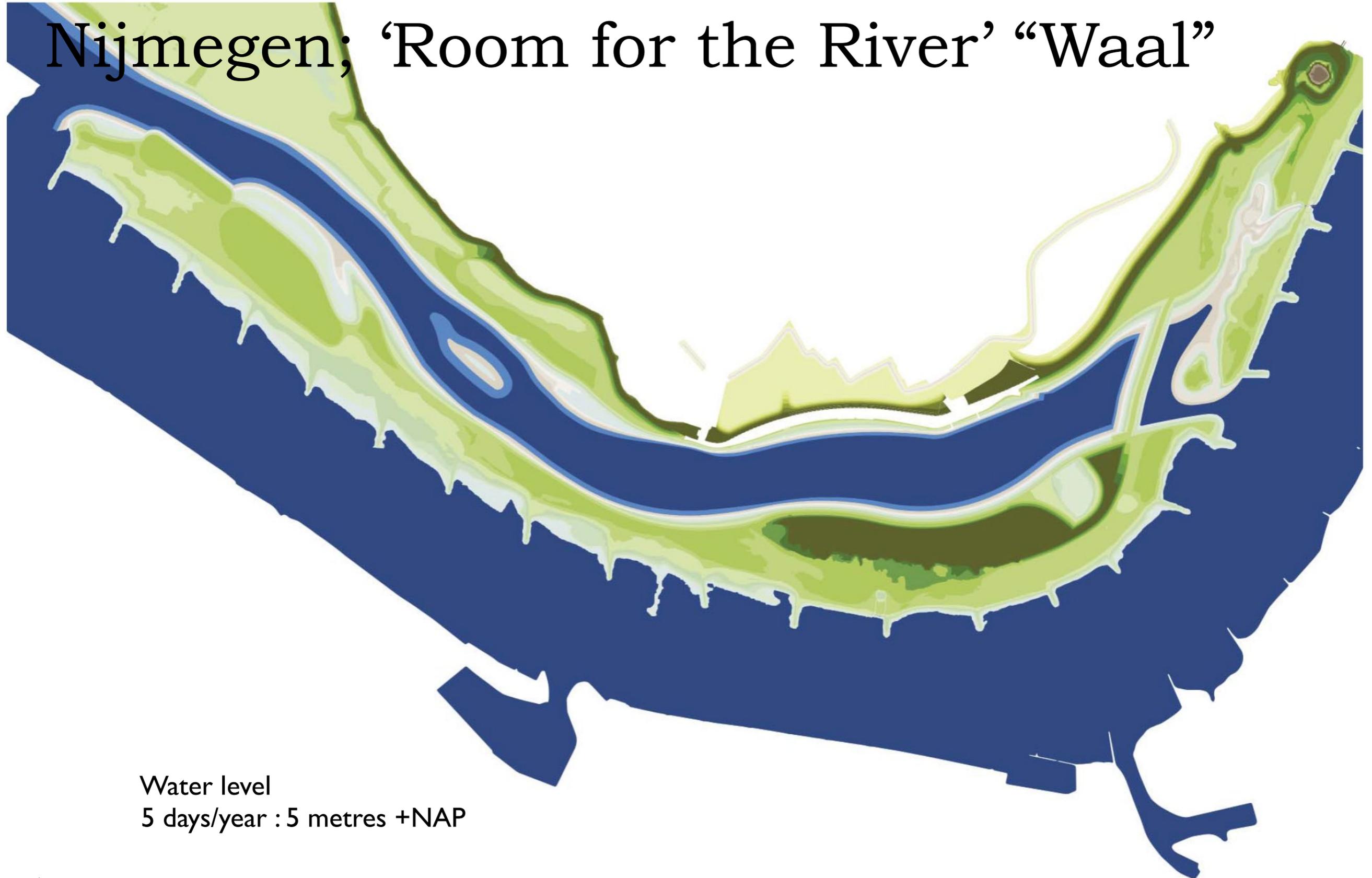
courtesy: H+N+S Landschapsarchitecten

Nijmegen; 'Room for the River' "Waal"



photo / copyright: Siebe Swart / Aeropicture

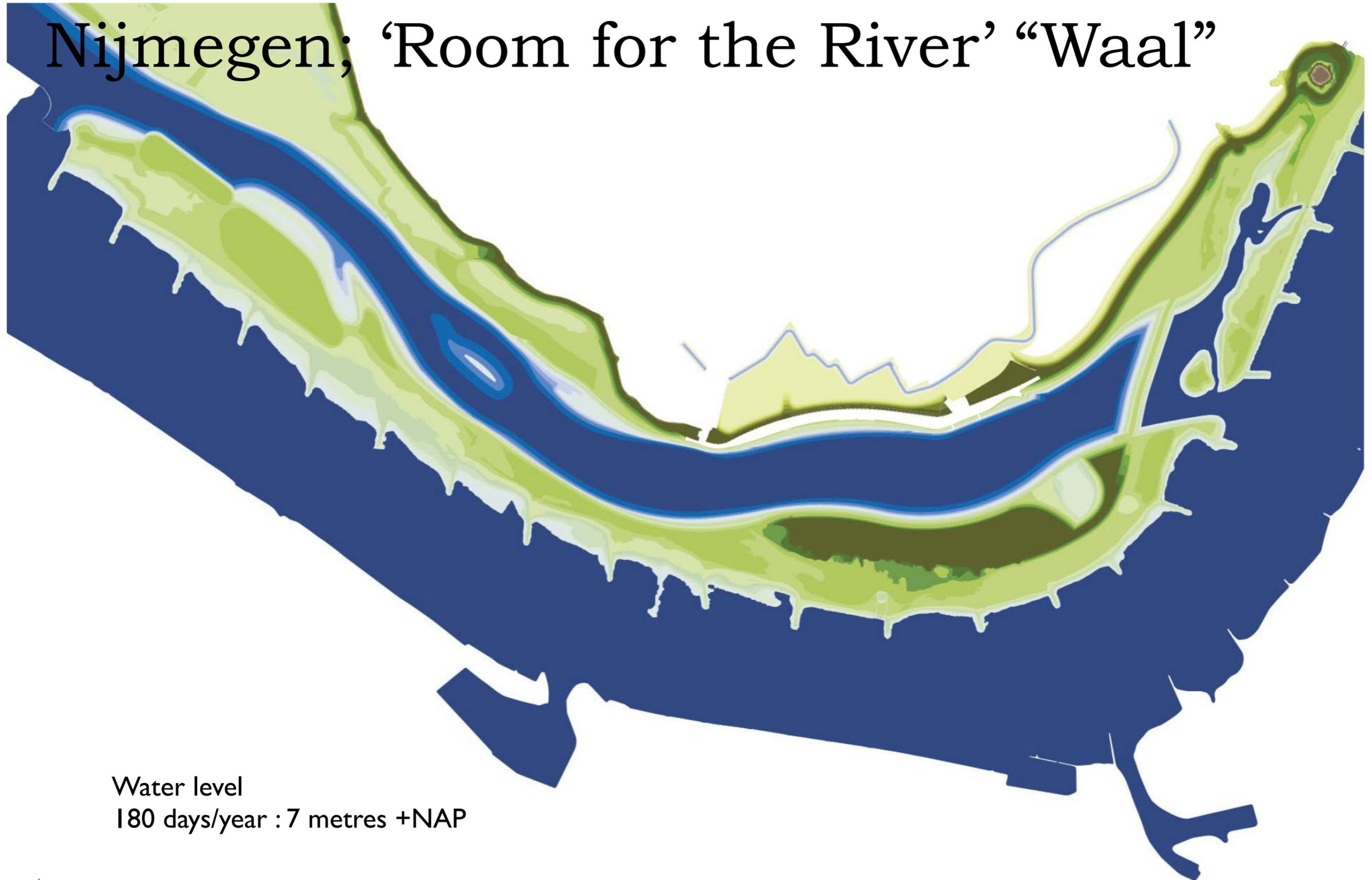
Nijmegen; 'Room for the River' "Waal"



Water level
5 days/year : 5 metres +NAP

courtesy: H+N+S Landschapsarchitecten

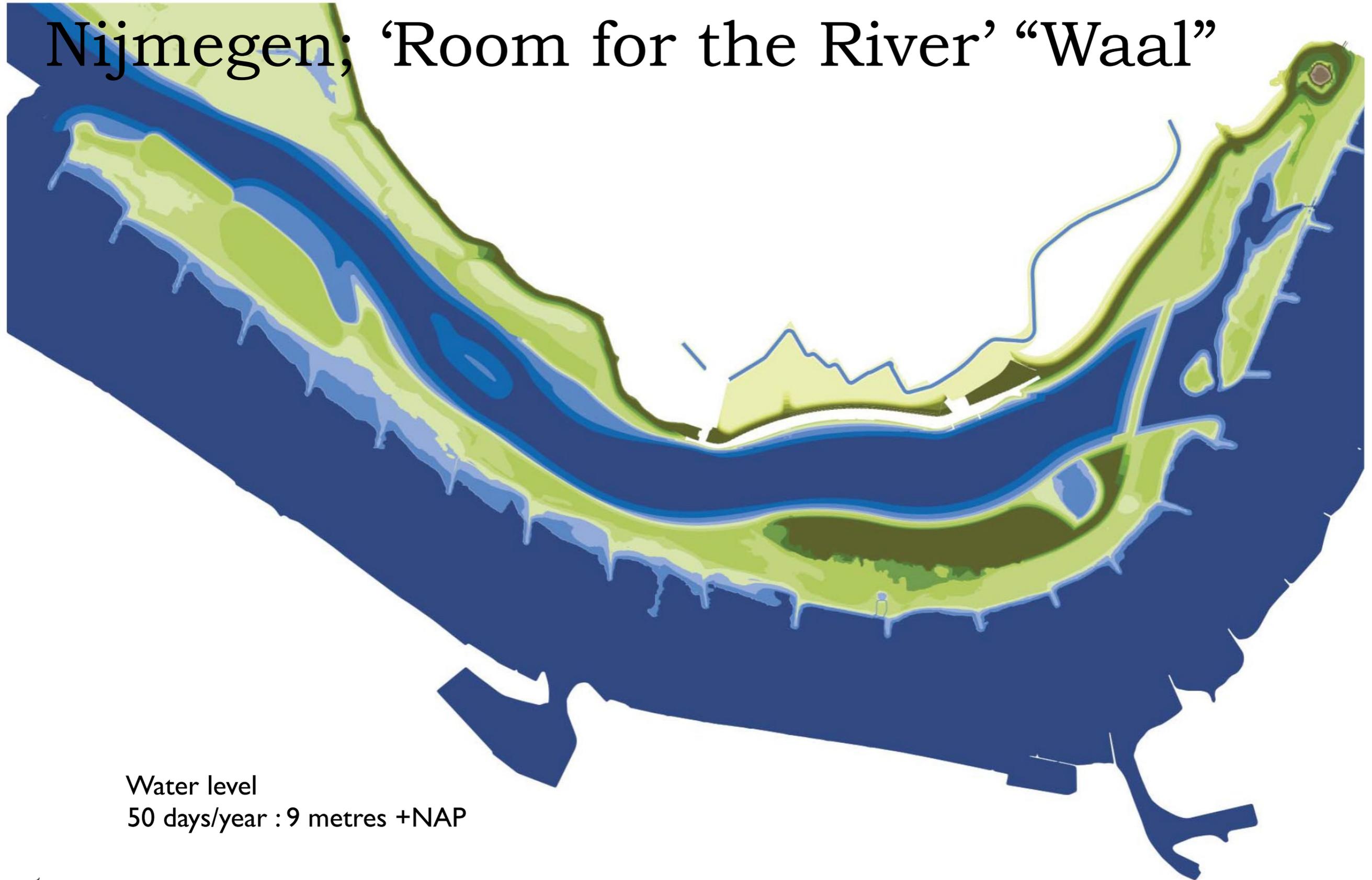
Nijmegen; 'Room for the River' "Waal"



Water level
180 days/year : 7 metres +NAP

courtesy: H+N+S Landschapsarchitecten

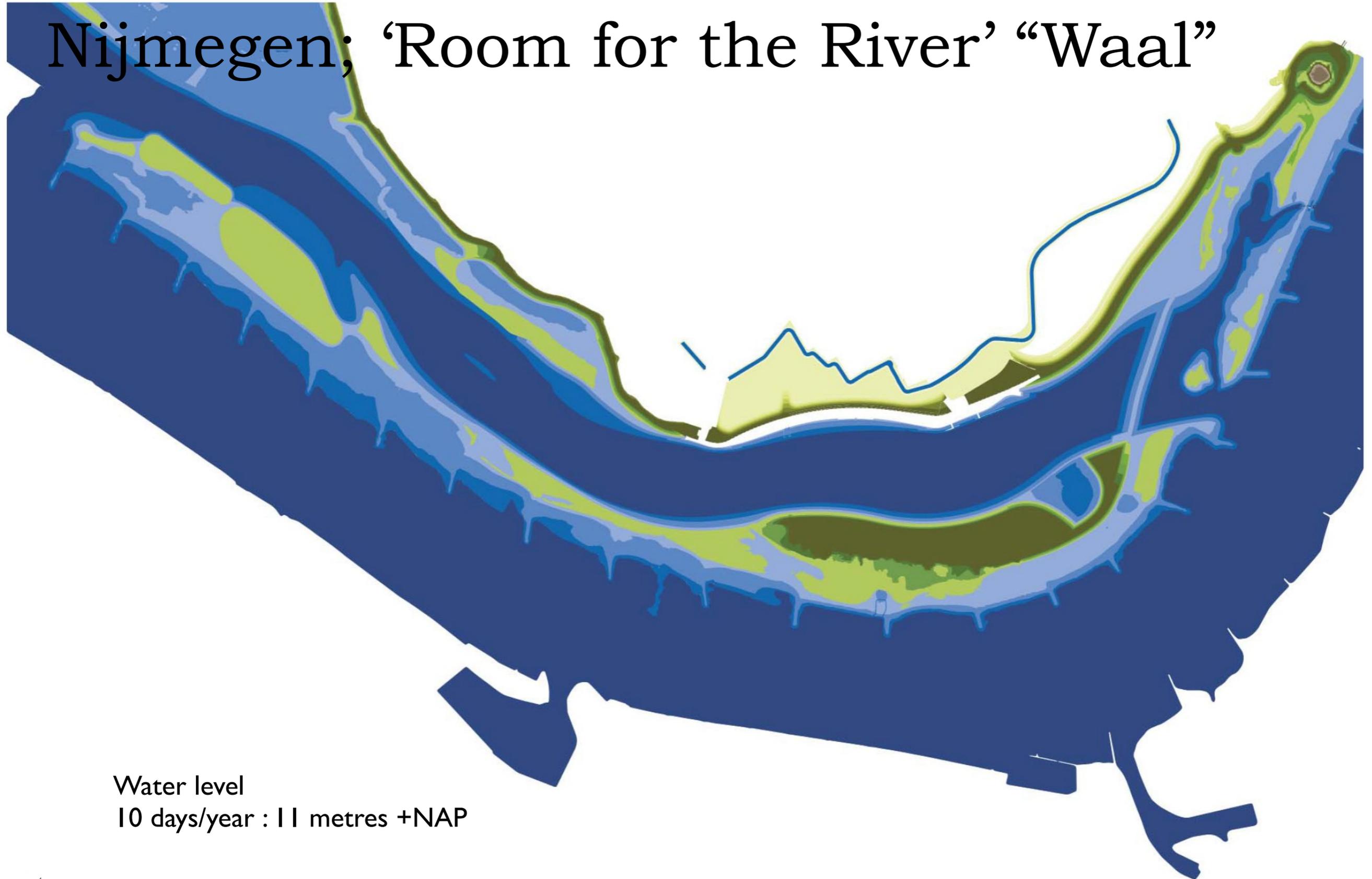
Nijmegen; 'Room for the River' "Waal"



Water level
50 days/year : 9 metres +NAP

courtesy: H+N+S Landschapsarchitecten

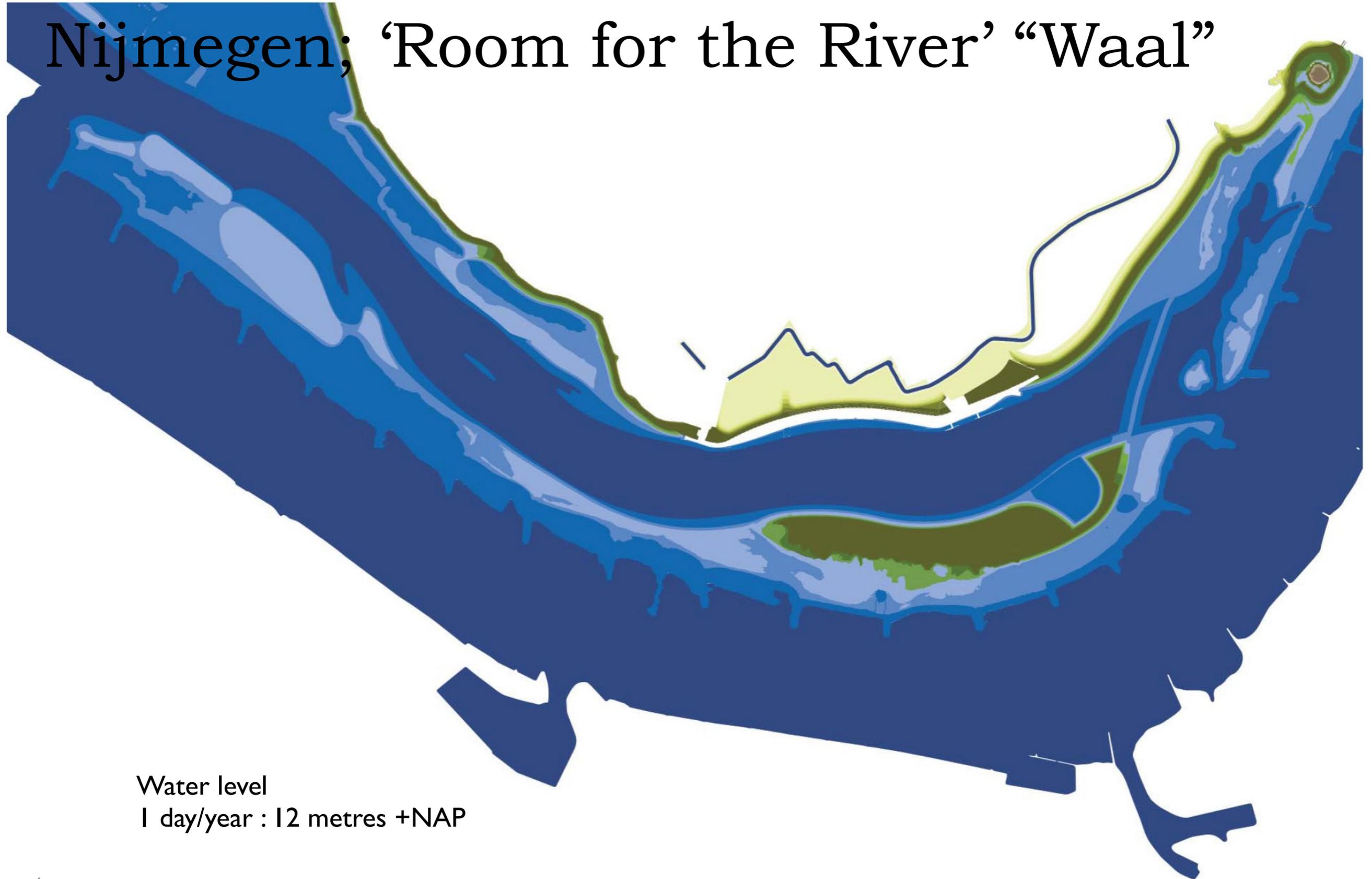
Nijmegen; 'Room for the River' "Waal"



Water level
10 days/year : 11 metres +NAP

courtesy: H+N+S Landschapsarchitecten

Nijmegen; 'Room for the River' "Waal"



Water level
1 day/year : 12 metres +NAP

courtesy: H+N+S Landschapsarchitecten

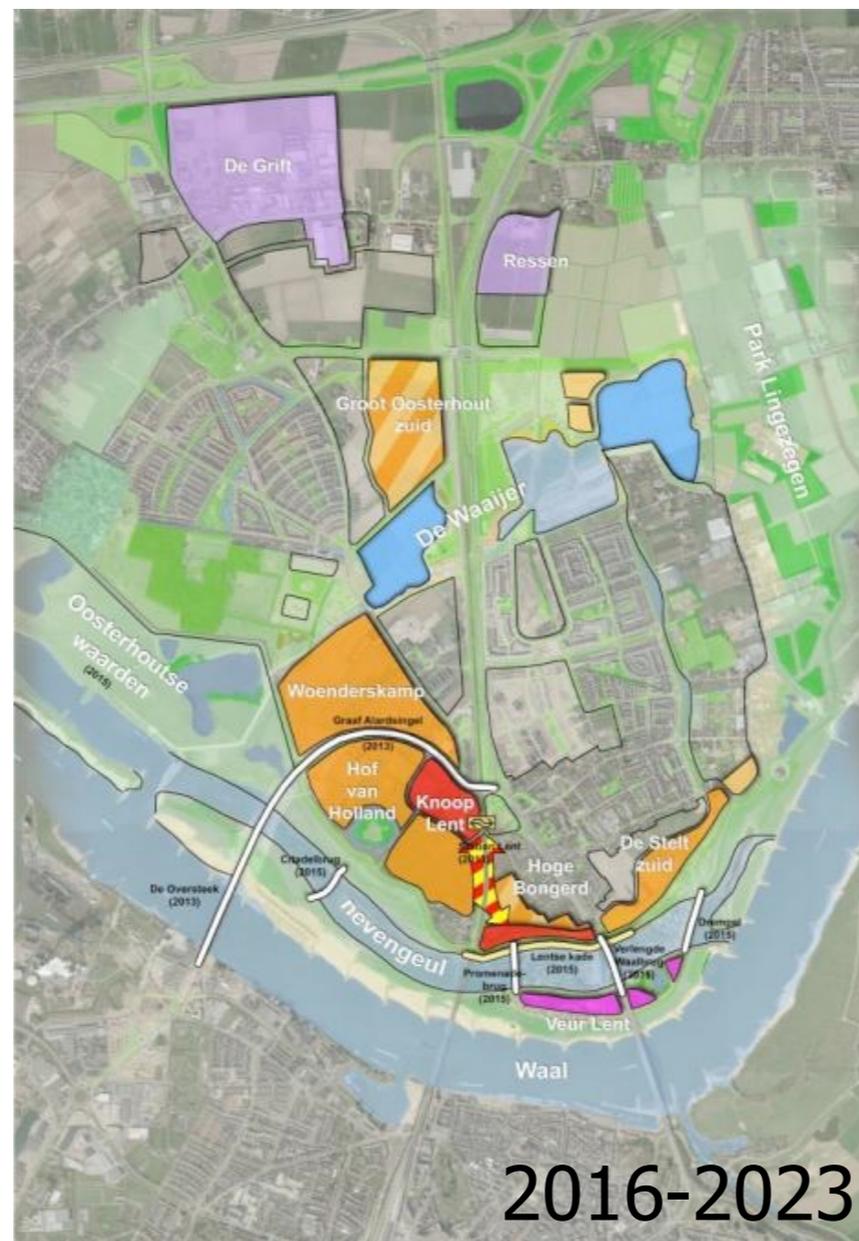
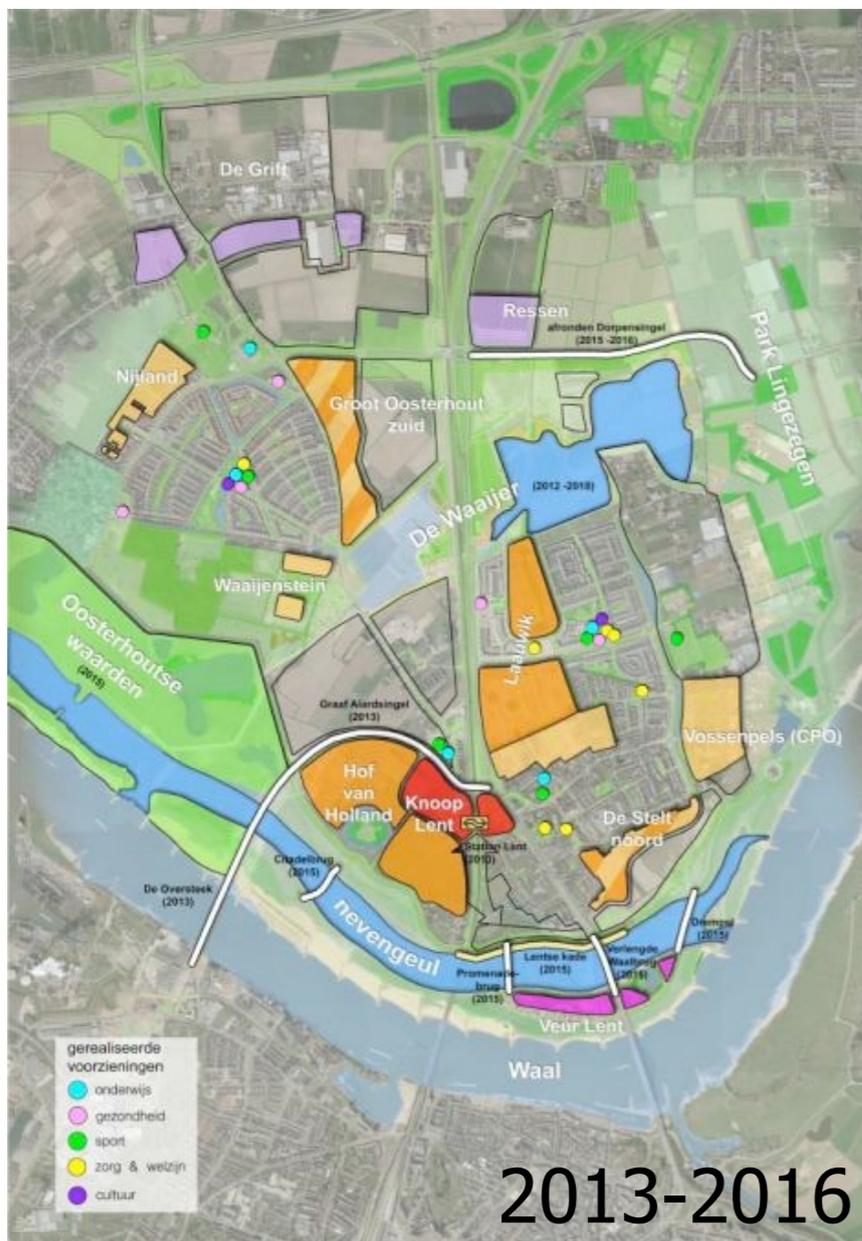
Nijmegen; 'Room for the River' "Waal"



photo / copyright: Siebe Swart / Aeropicture

Nijmegen; ‘Room for the River’ “Waal”

a regional perspective: Nijmegen-Arnhem (i)Lent development



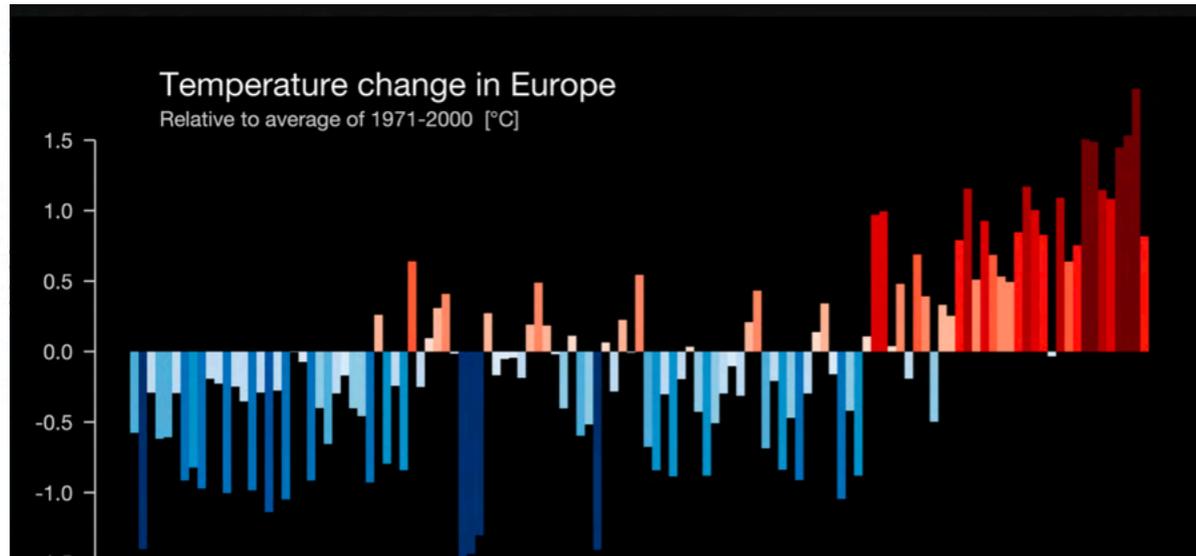


2.

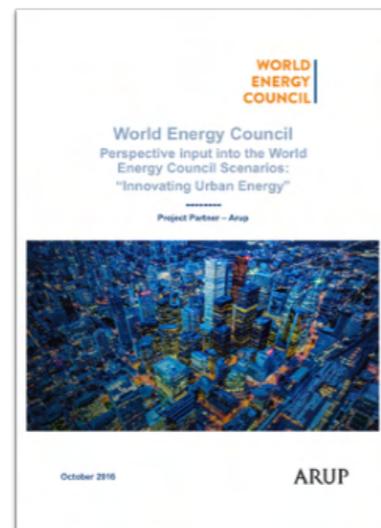
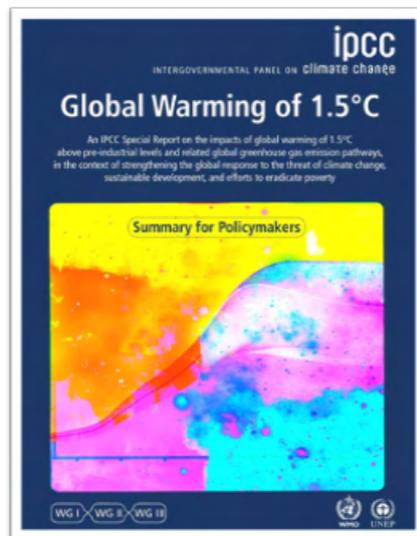
“Green/Blue Infrastructures for
Climate adaptiveness &
Sustainable, Attractive Cities”



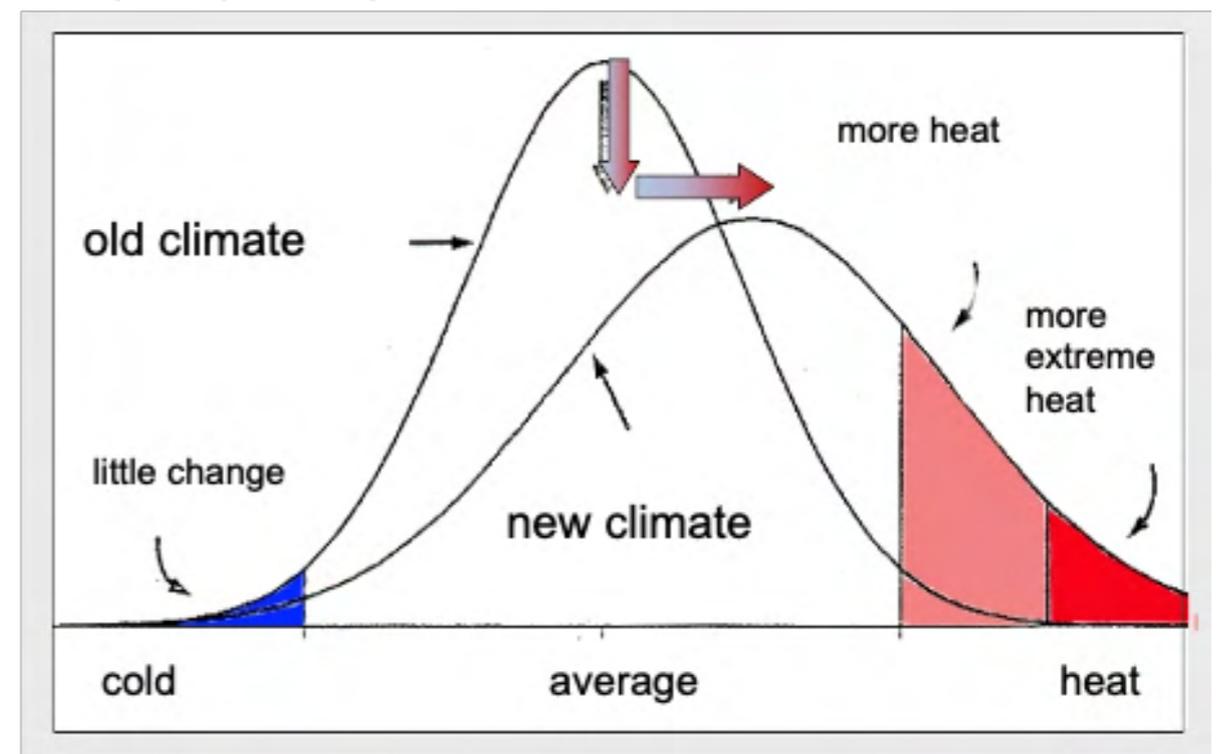
Climate Change and Adaptation Strategies




Climate Resilient Cities
Building preparedness and resilience by reducing cities' weaknesses and the impact of climate change: environmental, health related and societal.

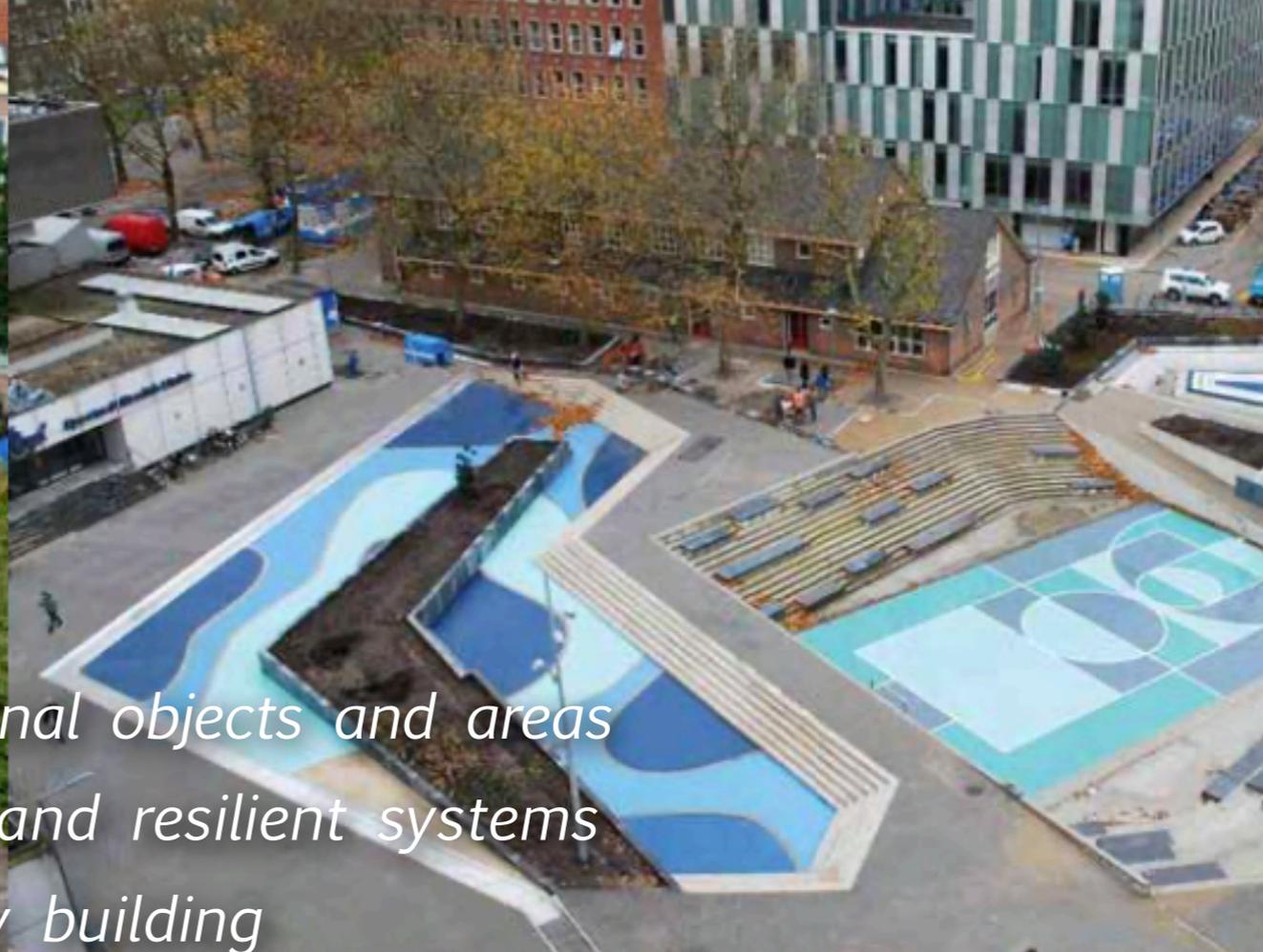


Frequency of daily Tmax



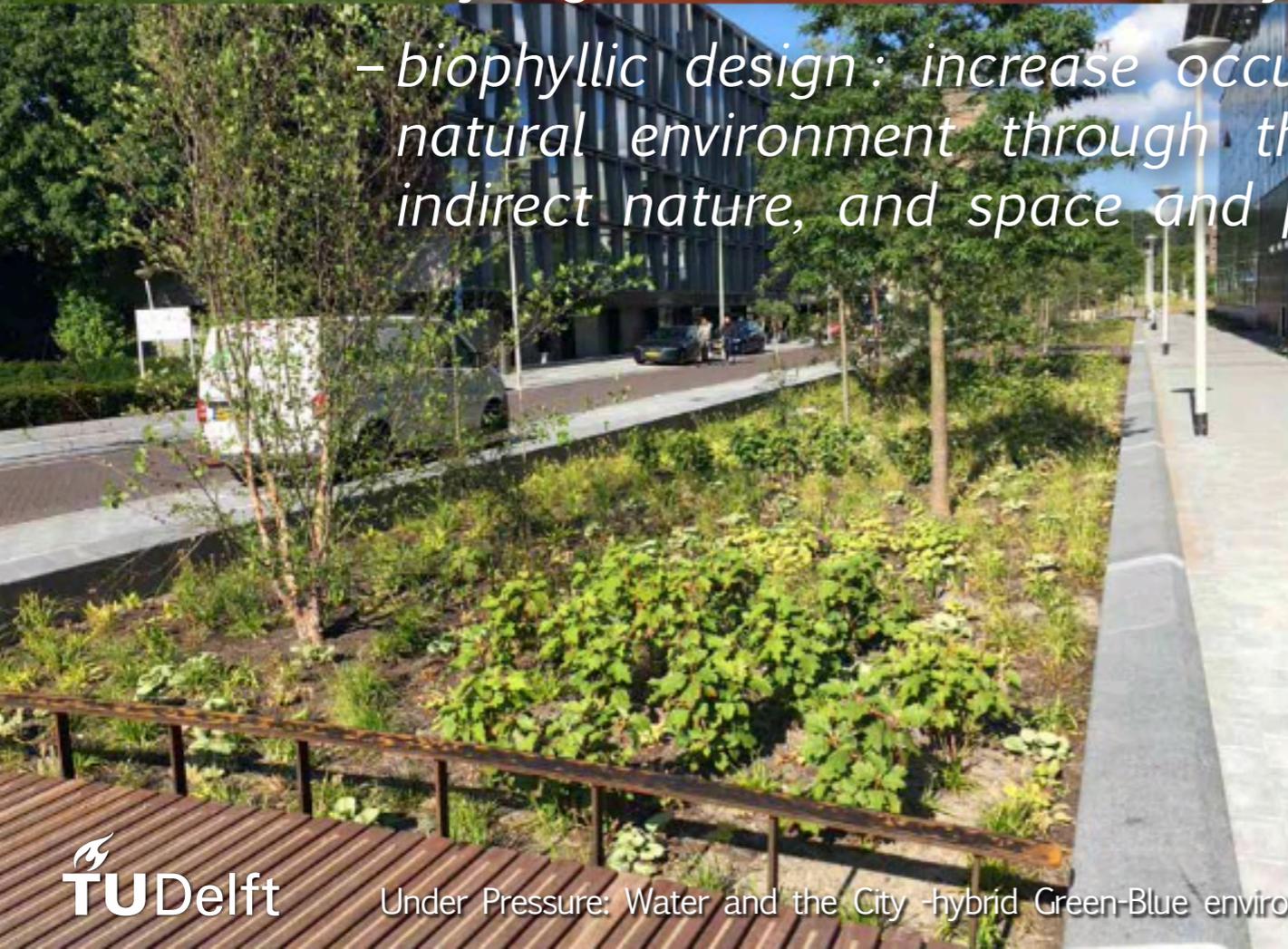
L.P. Hupfer, Nat.wiss.Rdsch. 5/04

Courtesy Daiela Maiullai / Dr. Marjolein Pijpers-Van Esch



towards:

- a 're-conceptualisation' of functional objects and areas*
- smart, integrated-, regenerative and resilient systems*
- self-organisation and community building*



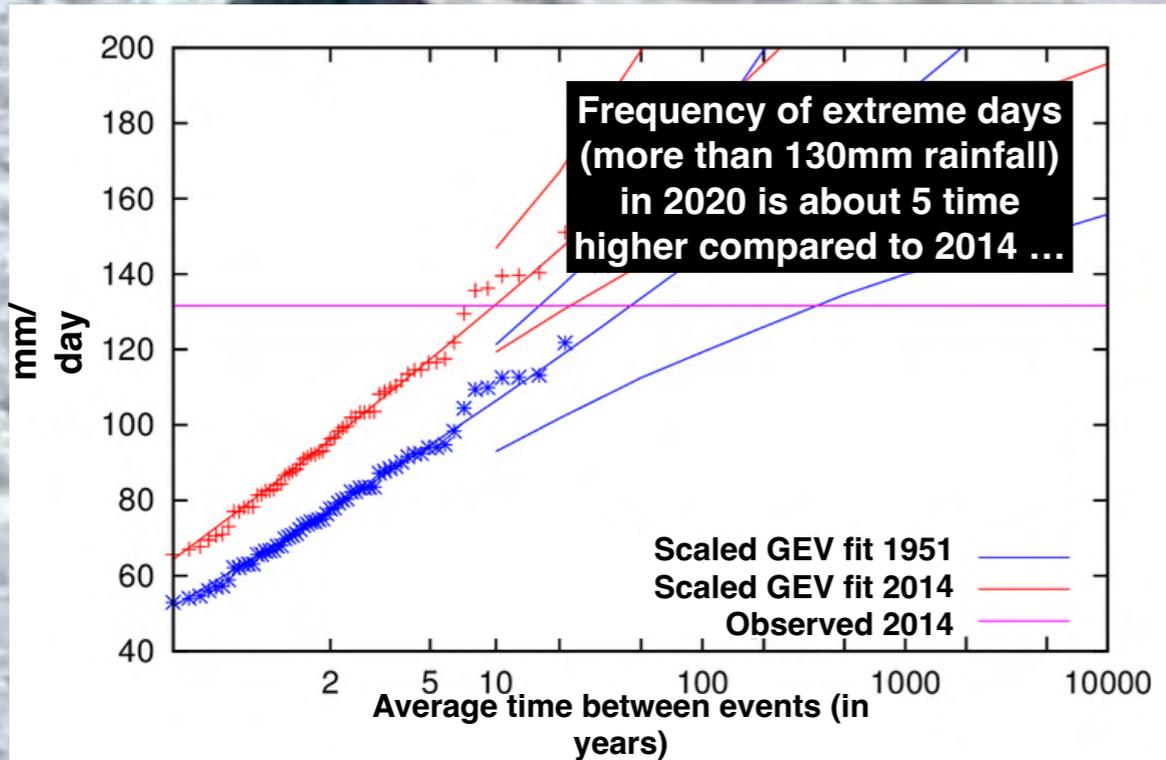
- biophillic design : increase occupant connectivity to the natural environment through the use of direct nature, indirect nature, and space and place environments.*

Climate Change and Adaptation Strategies



courtesy AMS Institute / PI prof Serge Hoogendoorn

Climate Change and Adaptation Strategies



courtesy AMS Institute / PI prof Serge Hoogendoorn

Climate Change and Adaptation Strategies



courtesy: Arjan van Timmeren

Adaptation strategies for excess rainfall in public space



Source: Nico Tillie / De Urbanisten

Bloemhofplein Rotterdam

Adaptation strategies for excess rainfall in public space



Source: Nico Tillie / De Urbanisten

Bloemhofplein Rotterdam

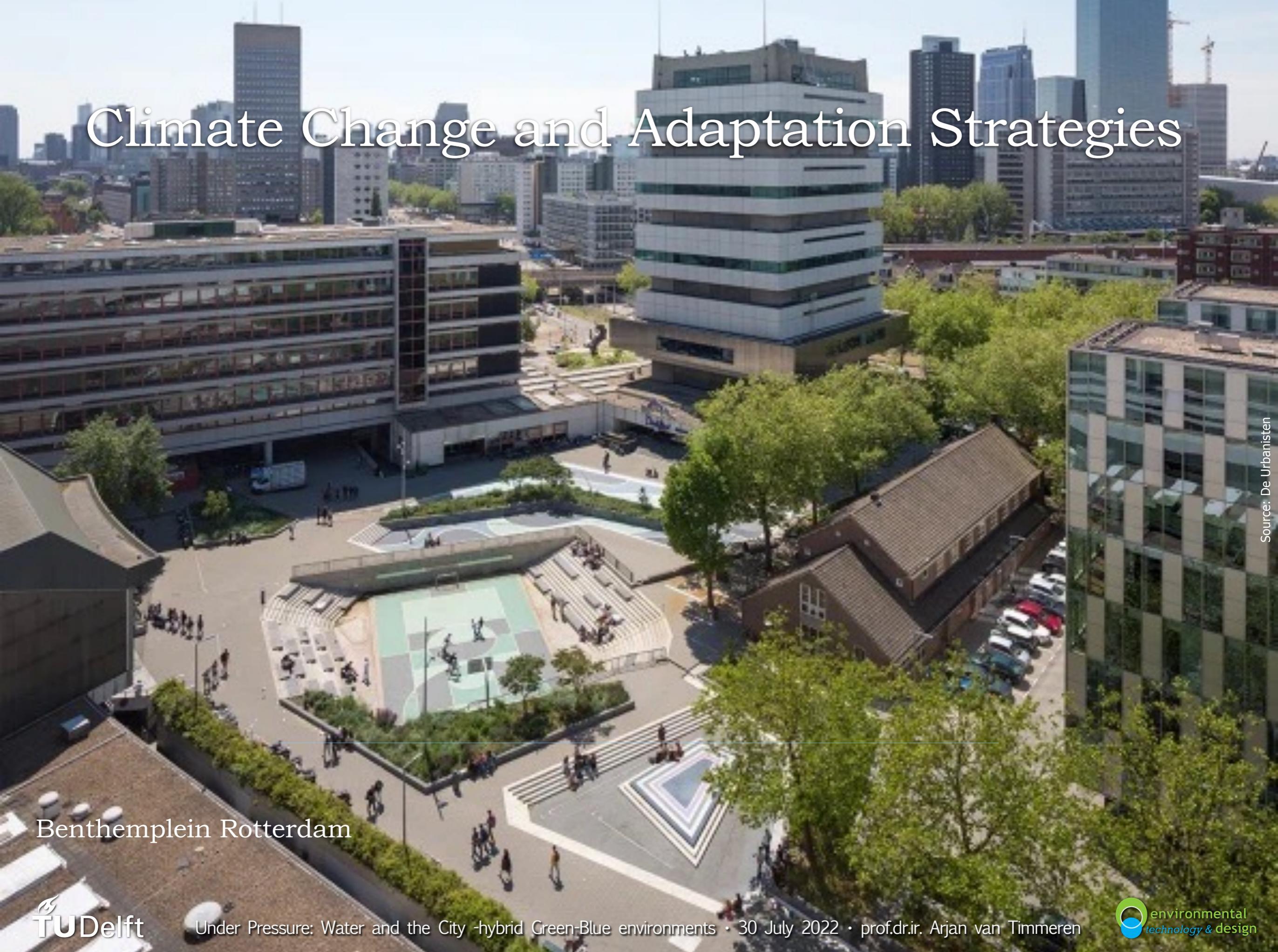
Adaptation strategies for excess rainfall in public space



Source: Nico Tille / De Urbanisten

Bloemhofplein Rotterdam

Climate Change and Adaptation Strategies



Source: De Urbanisten

Bentheplein Rotterdam

Climate Change and Adaptation Strategies



Benthemplein Rotterdam

Climate Change and Adaptation Strategies



Source: De Urbanisten



Benthemplein Rotterdam

Climate Change and Adaptation Strategies



Courtesy: Taneha Bacchin Kuznikov

The Urban Europe GB-Cities project

- **Paradigm-shift towards a more integrative/transdisciplinary approach** to achieve more sustainable urban water systems:
- **Economic and ecologic value** of utilising **green infrastructure** in city planning.
- **All forms of water are opportunities** to both alleviate and adapt to floods and droughts at the same time, as well as support liveability, ecosystems and biodiversity in the "water sensitive" city.
- **Yet, the pace of transition** from piped drainage systems to green infrastructure **is still slow** in Europe and many parts of the world.

The Urban Europe GB-Cities project

- **Develop knowledge and tools required to seize the opportunities** arising from future challenges.
- To **manage urban stormwater** in a way that **facilitates robust, synergistic and multi-functional green infrastructure** that will address today's and tomorrow's climate and other change in dynamic urban areas.
- To **accelerate the transition** from piped drainage systems to the use of surface based green infrastructure.
- To move **from 'problem-centred' stormwater management approach to one that is "opportunity-centre"**.

The Urban Europe GB-Cities project

International Urban Living Lab: Kiruna, Sweden



Image: White Architects AB (Stockholm) et al.

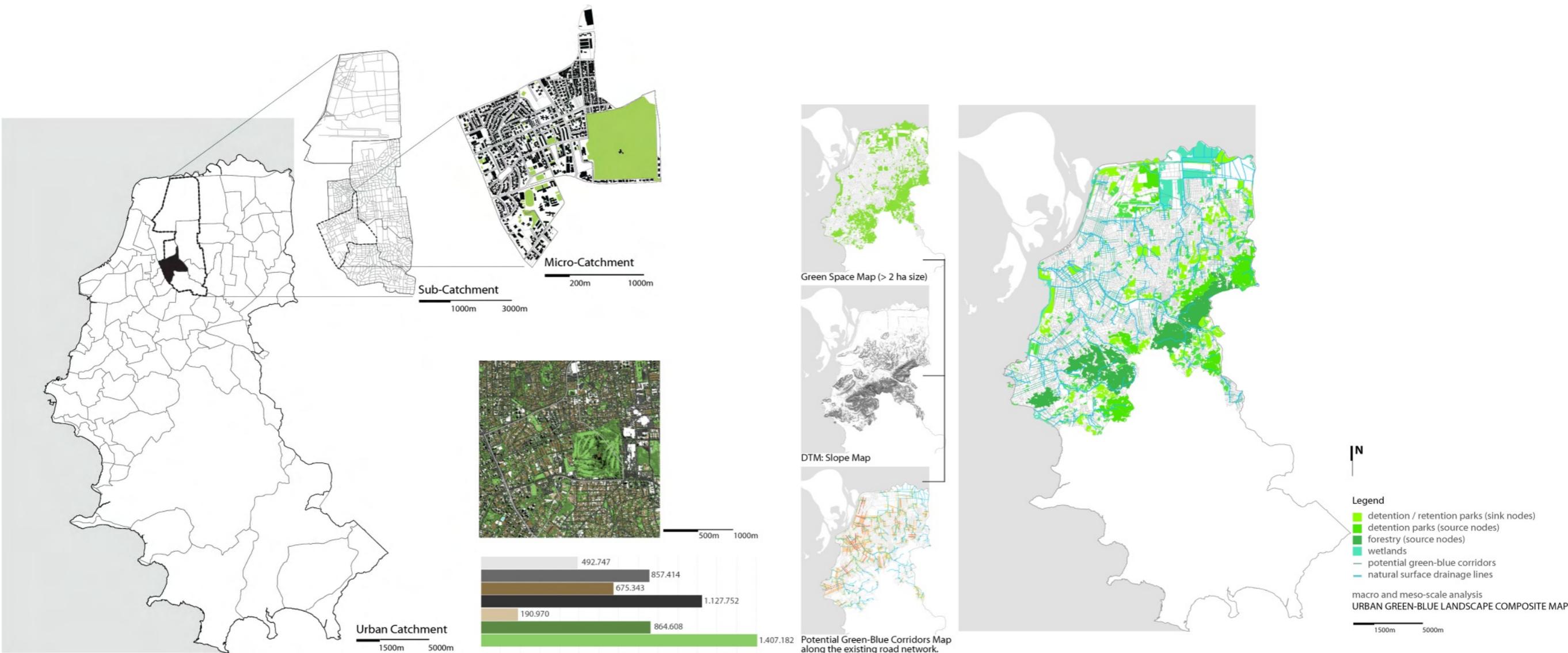
The Urban Europe GB-Cities project

'Urban' Living Lab: Northern River Delta (Netherlands)



Focus on smart spatial planning strategies

for attractive, sustainable and resilient urban environments, buildings, and infrastructures within the context of future changes

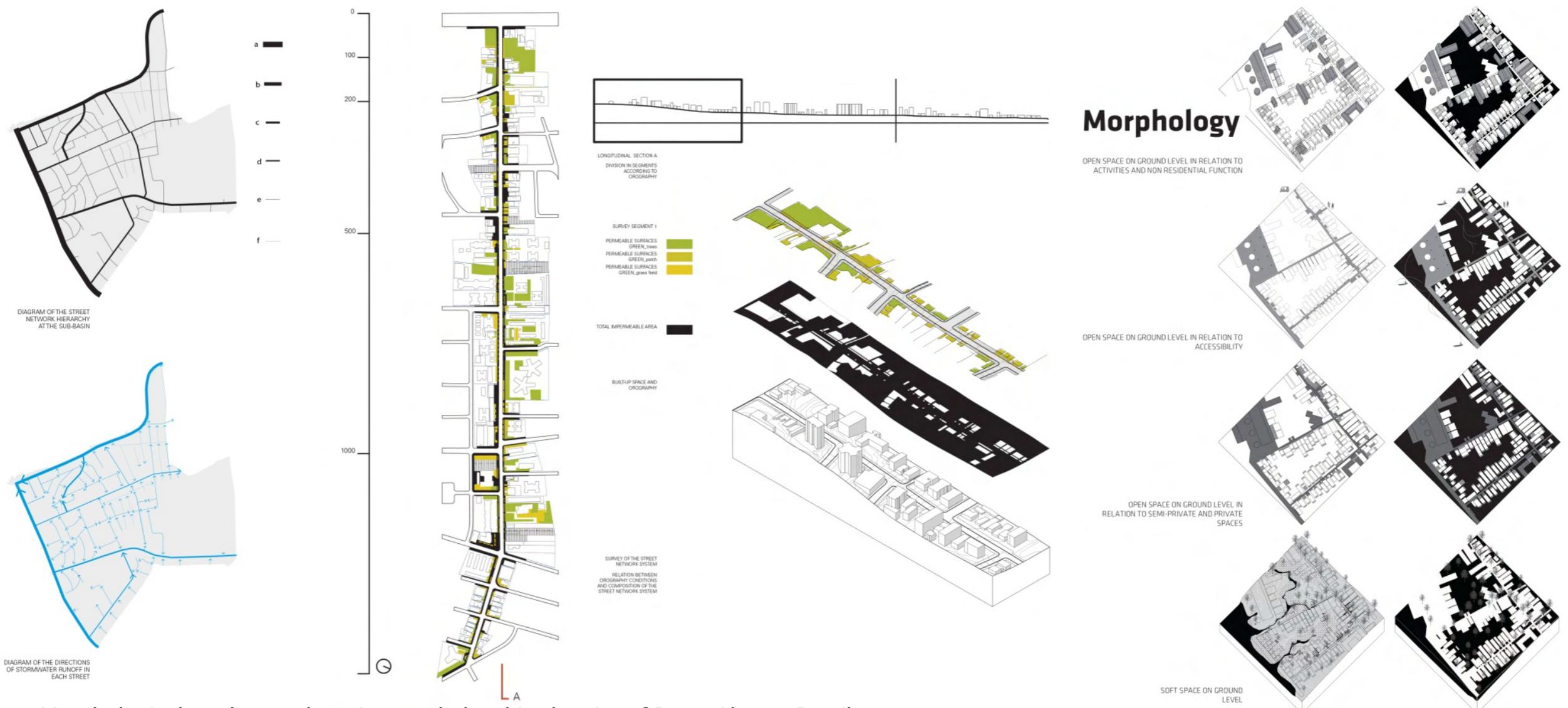


Multiscalar spatial analysis in the city of Porto Alegre, Brazil.

Source: Water Sensitive Urban Environments - PhD Research Project - T.K.Bacchin

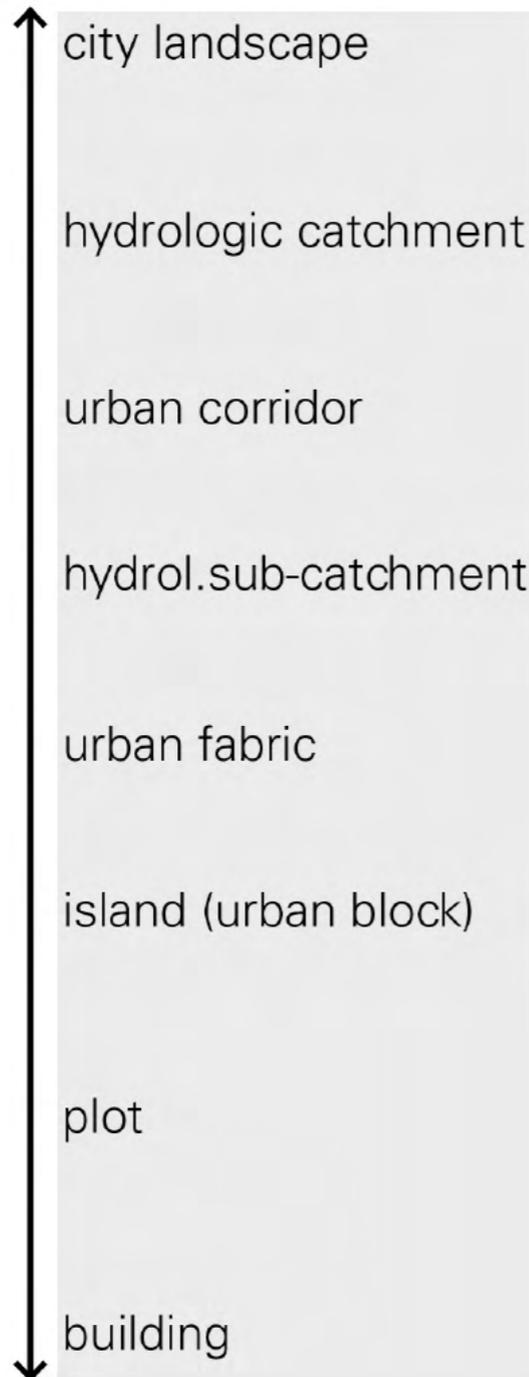
Focus on smart spatial planning strategies

for attractive, sustainable and resilient urban environments, buildings, and infrastructures within the context of future changes



Morphological studies at the micro-scale level in the city of Porto Alegre, Brazil.
Source: Water Sensitive Urban Environments - PhD Research Project - T.K.Bacchin

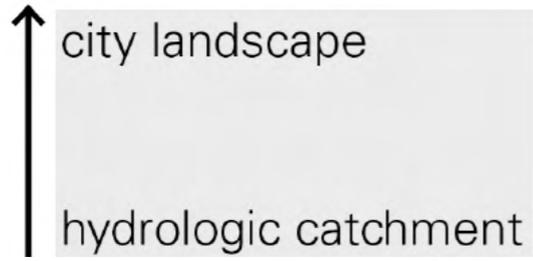
PLANNING
PUBLIC



URBANISM
COLLECTIVE

ARCHITECTURE
PRIVATE

PLANNING
PUBLIC



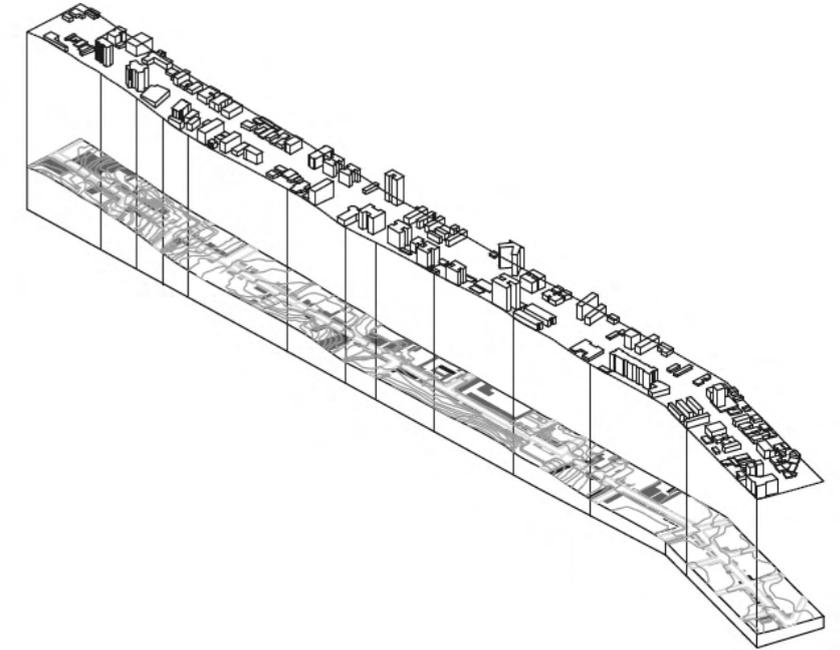
city /
hydrological basin



district /
hydrological sub-basin

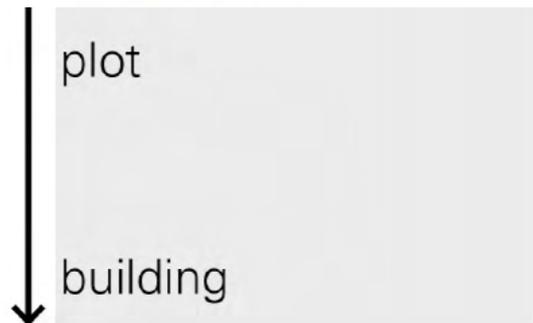


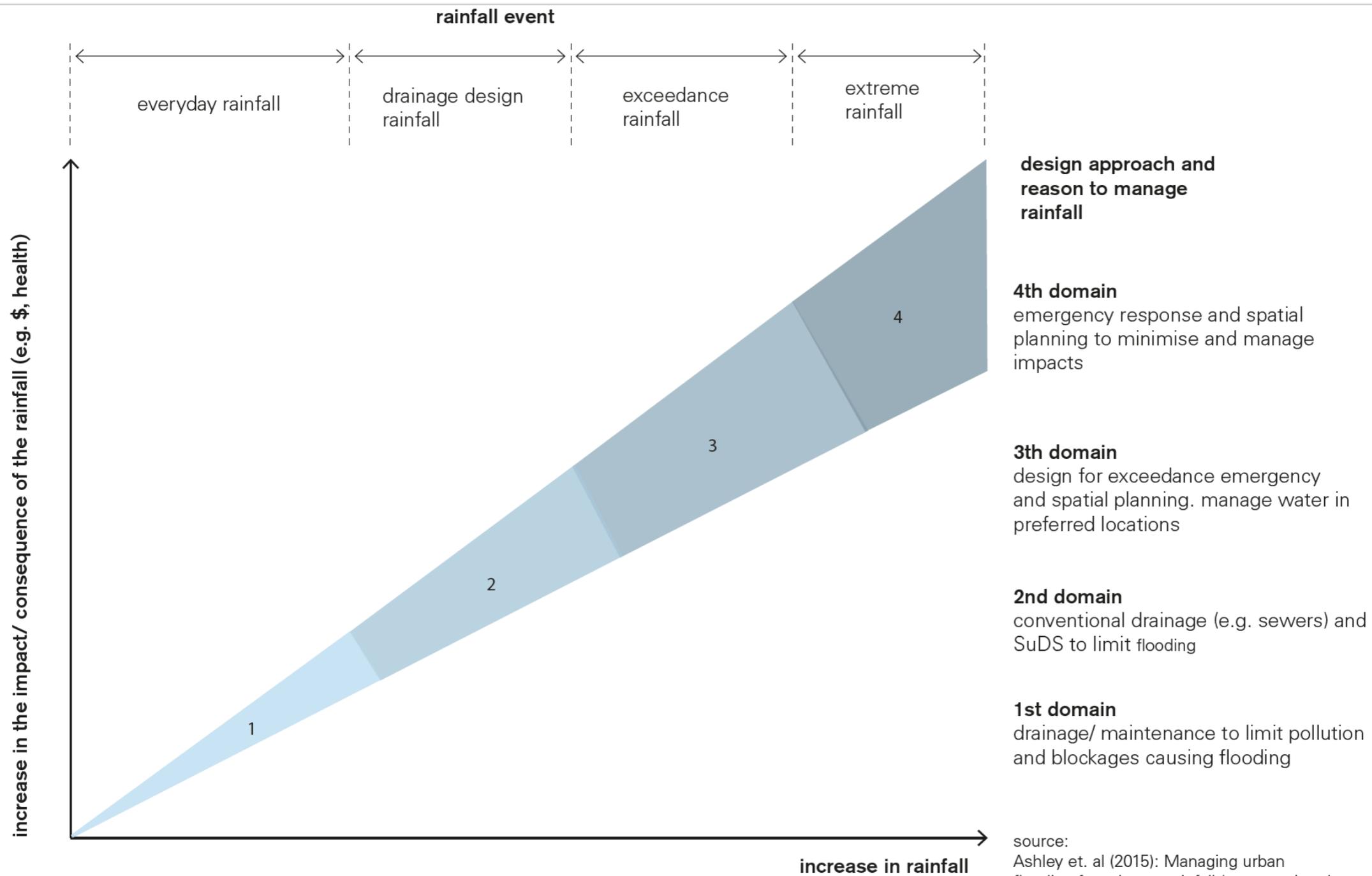
neighbourhood /
hydrological micro- basin

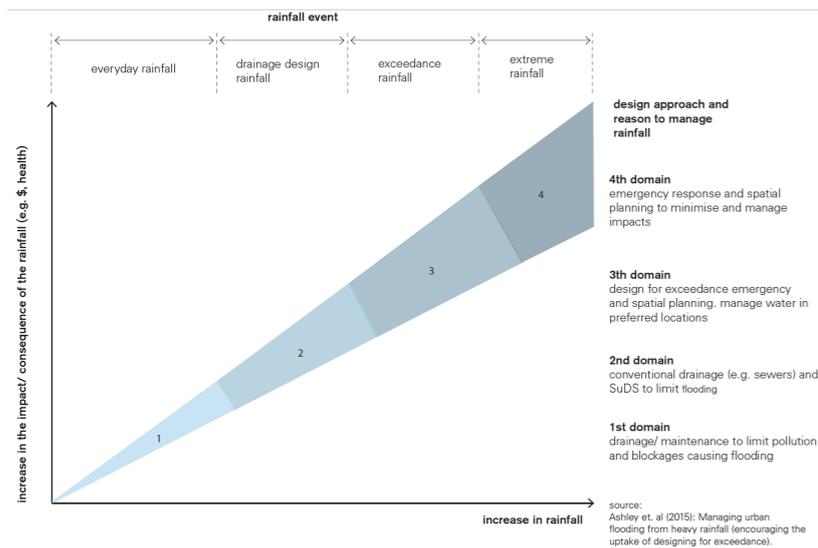


streetscape /
runoff source unit

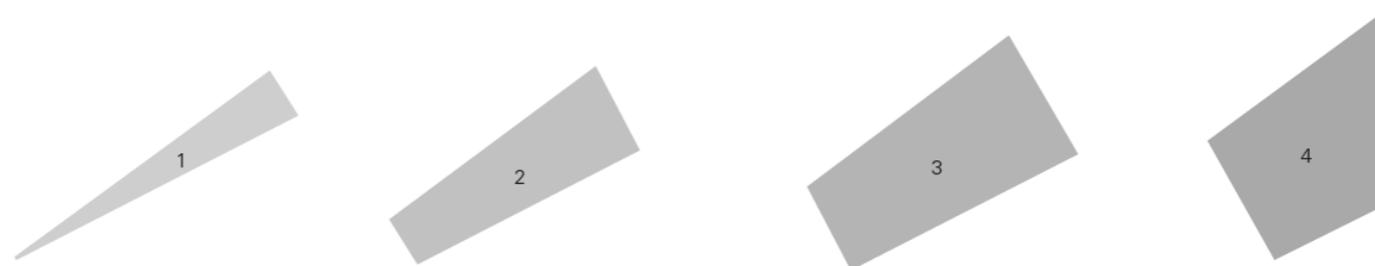
ARCHITECTURE
PRIVATE







source:
Ashley et. al (2015): Managing urban flooding from heavy rainfall (encouraging the uptake of designing for exceedance).



design approach and reason to manage rainfall

1. drainage/ maintenance to limit pollution and blockages causing flooding

- separated stormwater drainage system
- regulation of water flow of rivers
- reduce obstacles in the floodplain conveyance

2. conventional drainage (e.g. sewers) and SuDS to limit flooding

- delay drainage - infiltration
 - raingarden
 - infiltration planters
 - curbside raingarden
 - green roofs
 - swales
 - infiltration trench
 - pervious pavement
 - infiltration basin
- delay drainage - buffer/ storage
 - detention basin
 - retention pond
 - wetland
- water quality
 - water factory
 - sand trap filter

3. design for exceedance emergency and spatial planning, manage water in preferred locations

- conveyance and storage of exceedance flows
- diversion structures
 - river bypass
 - berms
- conveyance structures:
 - swales
 - ditches
 - street gutters
 - urban creek
- multipurpose spaces
 - green areas
 - flodable public spaces
 - sport courts
 - playgrounds
 - parking spots
 - traffic islands
 - small streets
- green reservoirs
 - reedbeds
 - forebay
- underground structures
 - underground tanks, cisterns and pools
- attenuating flow peaks
 - land form depressions in the canal forming public spaces

4. emergency response and spatial planning to minimise and manage impacts

- diversion structures
 - paths for flood return to river
 - cloudburst boulevards
 - underground diversion tunnel
- emergency measures
 - connection with multiple bridges
 - amphibious houses
 - houses starting one storey upper the street level
 - concrete frame buildings for structure resistance against water
 - scape routes

improve awareness- all domains

- | | | | |
|---|---|--|--|
| <ul style="list-style-type: none"> • combine green with blue infrastructures • implement public meeting spaces close to green blue infrastructures • implement perennial open water structures • change water into a playful structure • transform water facilities into parks | <ul style="list-style-type: none"> • propose seasonal design • change public spaces into floodable spaces • implement open gutters, canals, creeks • introduce green blue elements into the landscape | <ul style="list-style-type: none"> • introduce variety of landscapes in different districts • transform urban spaces into a more natural habitat • generate system of green blue spaces in urban areas • bring people closer to water bodies • bring water bodies closer to people • implement more water lowers the ambient temperature in summer | <ul style="list-style-type: none"> • implement more water binds dust particles • implement more water humidifies the air • implement riverfront parks revive the presence of the rivers • transform green roofs into rooftop gardens |
|---|---|--|--|





Climate Change and Adaptation Strategies

finding 'lost (public) spaces' ...

Source: J. Hewitt - High Line before redevelopment via commons.wikimedia.org. CC BY SA

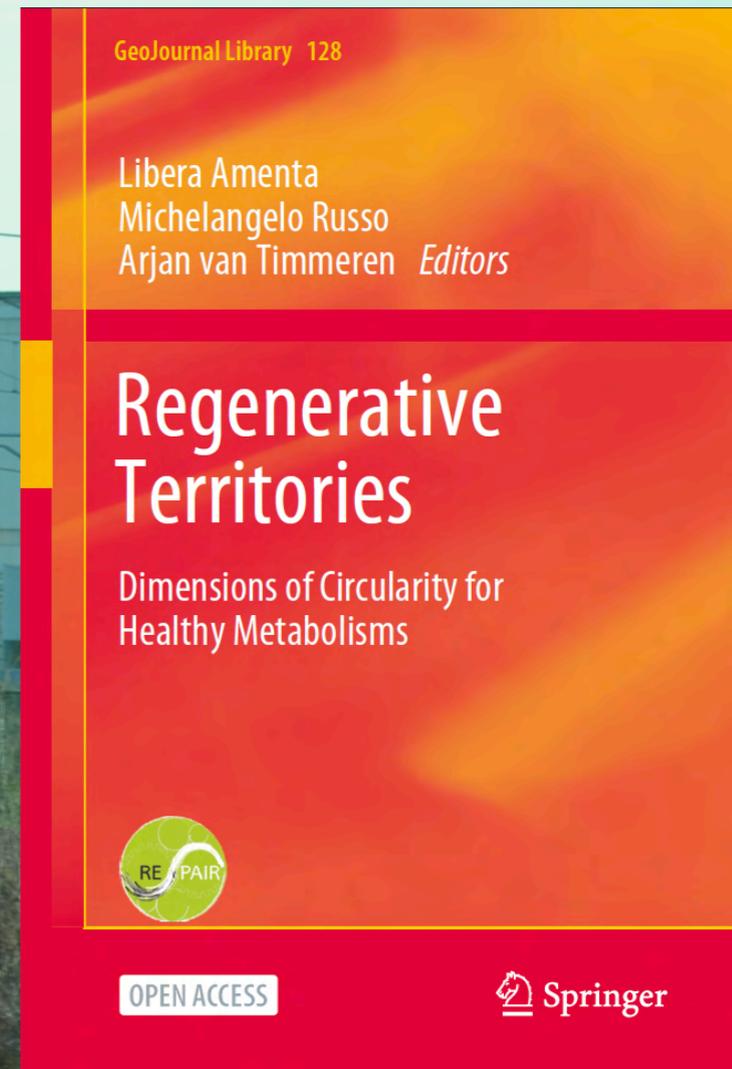
Climate Change and Adaptation Strategies

finding 'lost (public) spaces' ...
... towards Regenerative-scapes

image: Arjan van Timmeren

Wastescapes include abandoned territories, underused areas, former and often polluted industrial areas, bare lands, and indefinite interstitial spaces, as well as the operational landscape and infrastructure of waste (management)...

Defined as: parts of landscapes going through a linear transition from valuable, accessible, public and natural landscapes, towards a variety of impacted areas involving wastefulness, inaccessibility, social and environmental degradation, and ‘decreasing natural value’



Latest Publication and Open Access book, in the GeoJournal Library series by Springer:
Amenta, L., Russo, M.A. & van Timmeren, A. (2022) Regenerative Territories. Dimensions of Circularity for Healthy Metabolisms

Download: <https://link.springer.com/book/9783030785352>

Amenta, L. & van Timmeren, A. (2018)
Beyond wastescapes: towards circular landscapes Addressing the spatial dimension of circularity through the regeneration of wastescapes
MDPI Special Issue, Journal of Sustainability

Climate Change and Adaptation Strategies



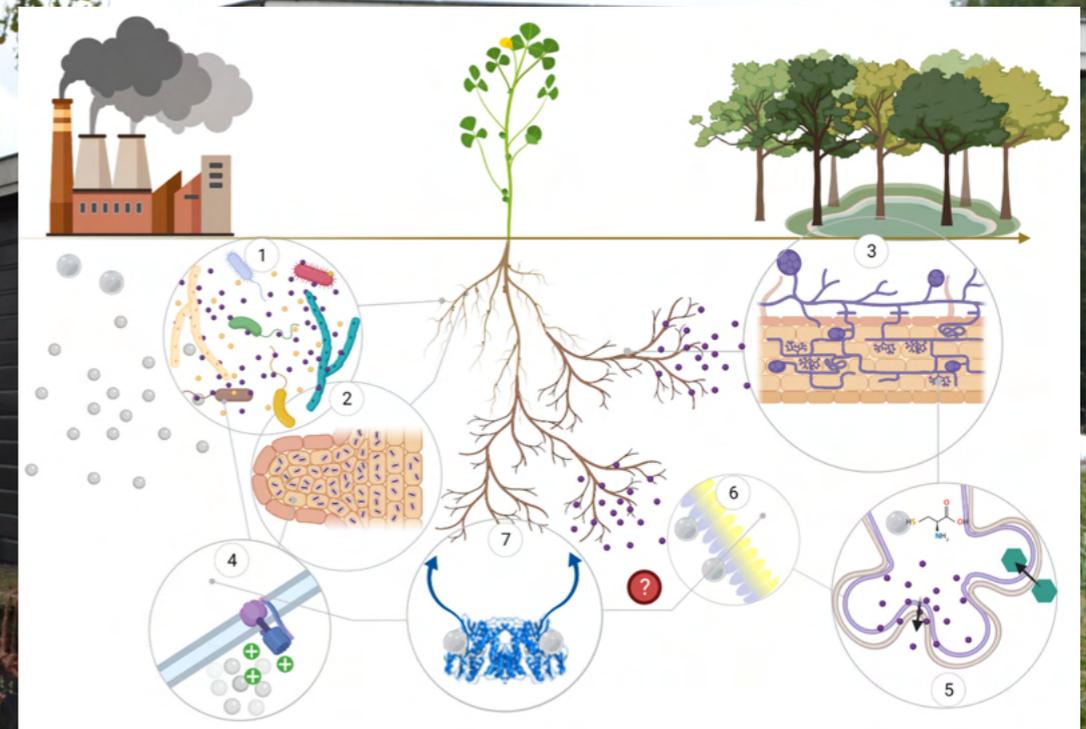
footage: Arjan van der Timmeren

Finding 'lost (public) spaces' ...

... towards Regenerative-scapes

courtesy AMS Institute | Ellen van Bueren & Kris Steen

Finding 'lost (public) spaces' ...



... towards Regenerative-scapes: applying phytoremediation (and different governance models)

Finding 'lost (public) spaces', introducing biophylic design ...



... towards Regenerative-scapes:
nutrient recovery and anaerobic digestion



(post-port) Area development 'Buiksloterham'



(post-port) Area development 'Buiksloterham'

'scaling up' / lessons learned (including Co-creation)

from 'De Ceuvél'
to 'Schoonschip'

(post-port) Area development 'Buiksloterham'

'scaling up' /lessons learned (including Co-creation)

from 'Schoonschip'
to 'Buiksloterham' area

... 'de Ceuvel', 'Schoonschip', 'Buiksloterham'



De Ceuvel

SchoonSchip

Source: Municipality of Amsterdam, Buiksloterham Circulair, amsterdamwerkt.nl (2020)

(post-port)Area development A'dam 'Havenstad'

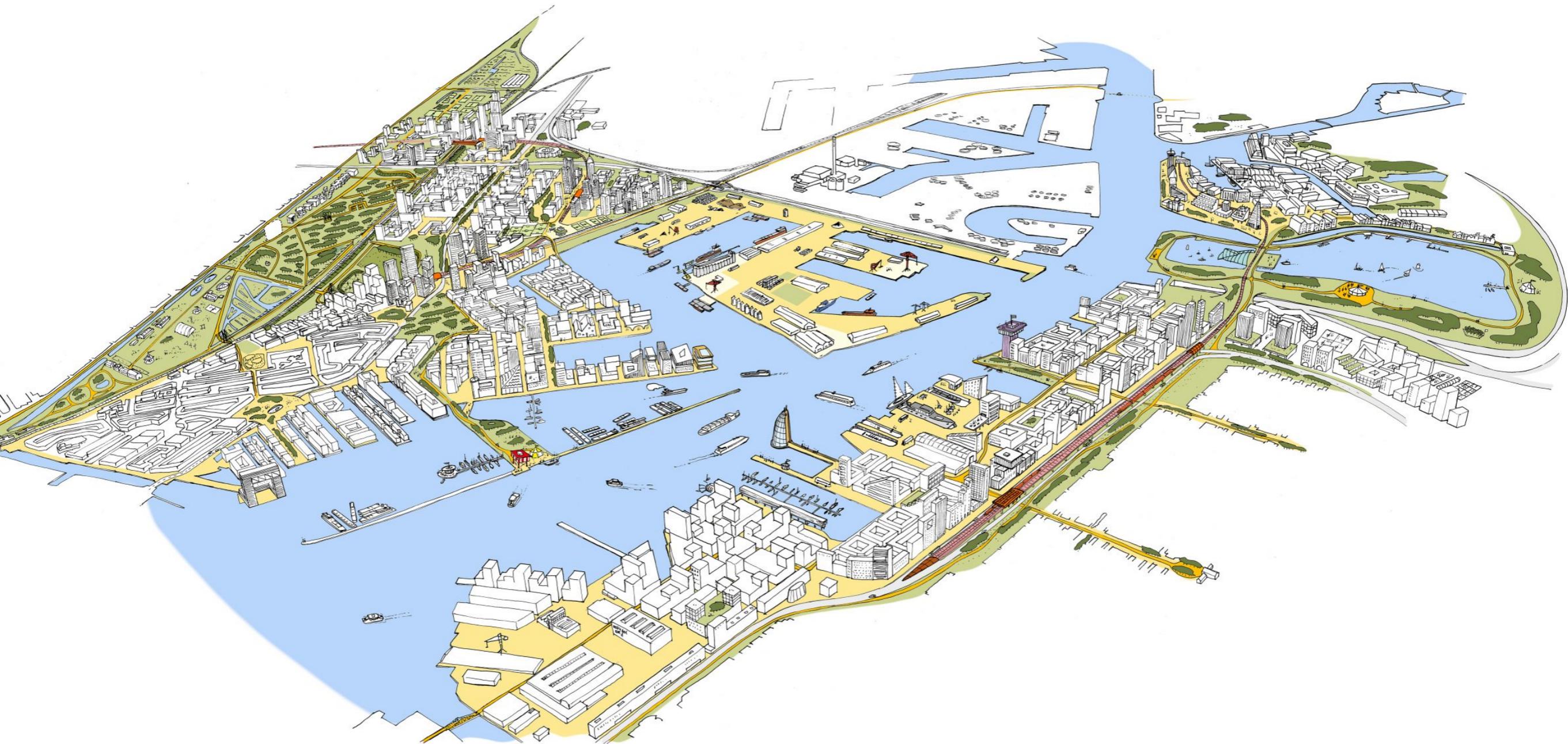
'scaling up' /lessons learned



"Het getoonde beeld van het waterfront is nog aan wijzigingen onderhevig"

Source: Municipality of Amsterdam, Buiksloterham Circulair, amsterdamwerkt.nl (2020)

Area development 'Havenstad' Amsterdam



Area development 'Havenstad' Amsterdam





re

think • create
search • use
design • build
write • make
do • consider
imagine !



<https://www.tudelft.nl/bk/over-faculteit/afdelingen/urbanism/organisatie/secties/environmental-technology-and-design>

<https://www.tudelft.nl/extensionschool/portfolio/sustainable-cities>

<https://convergencealliance.nl/nl/resilient-delta>

www.ams-institute.org

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Department Urbanism

- P.I. AMS Institute (MIT, TUD, WUR)
- Scientific Director Resilient Delta (EUR, TUD, EMC)
- Academic Portfolio Director TUD Extension School

