Climate adaptation on a metropolitan scale

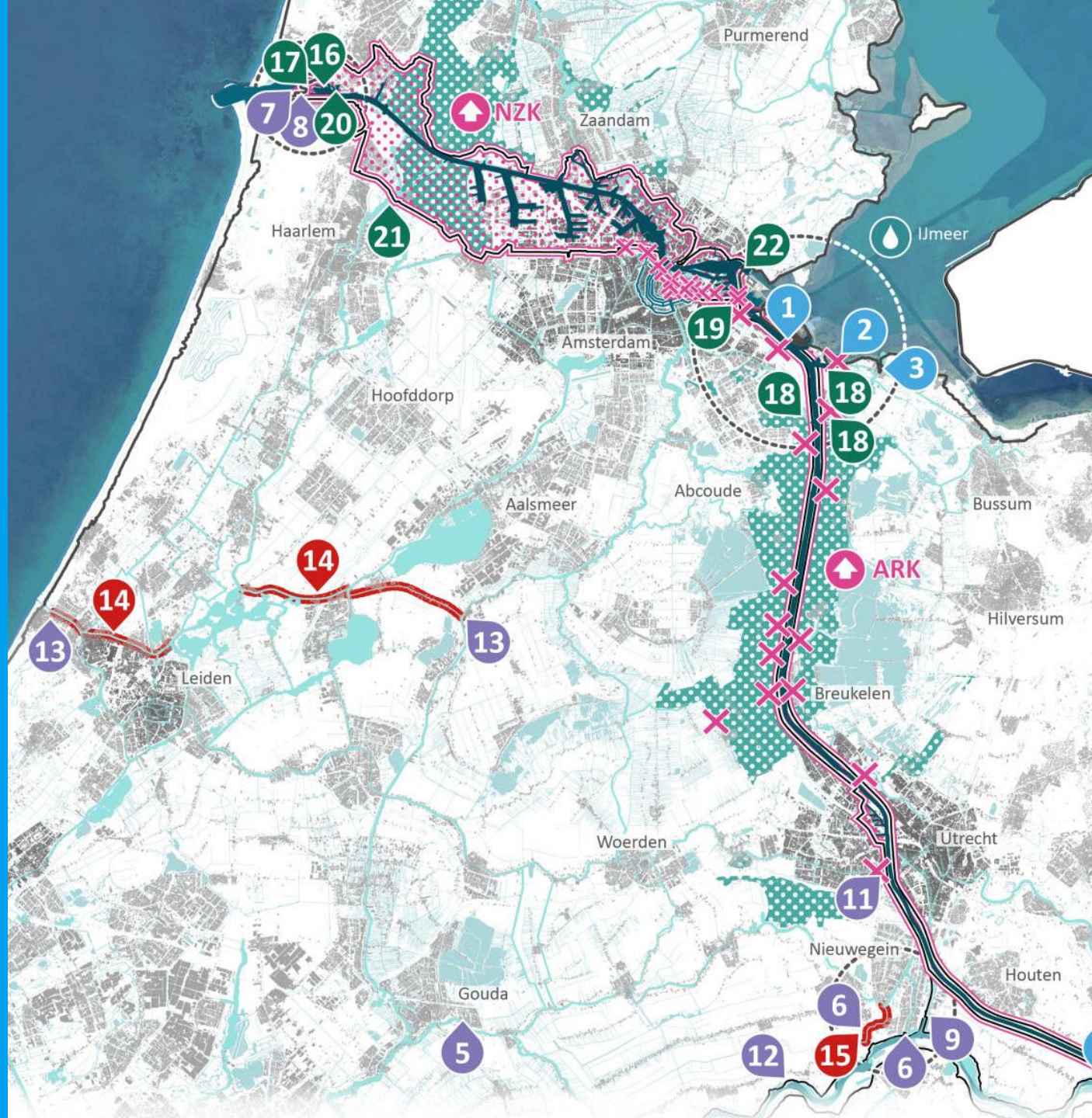
Webinar METREX

March 5th 2025

Kasper Spaan

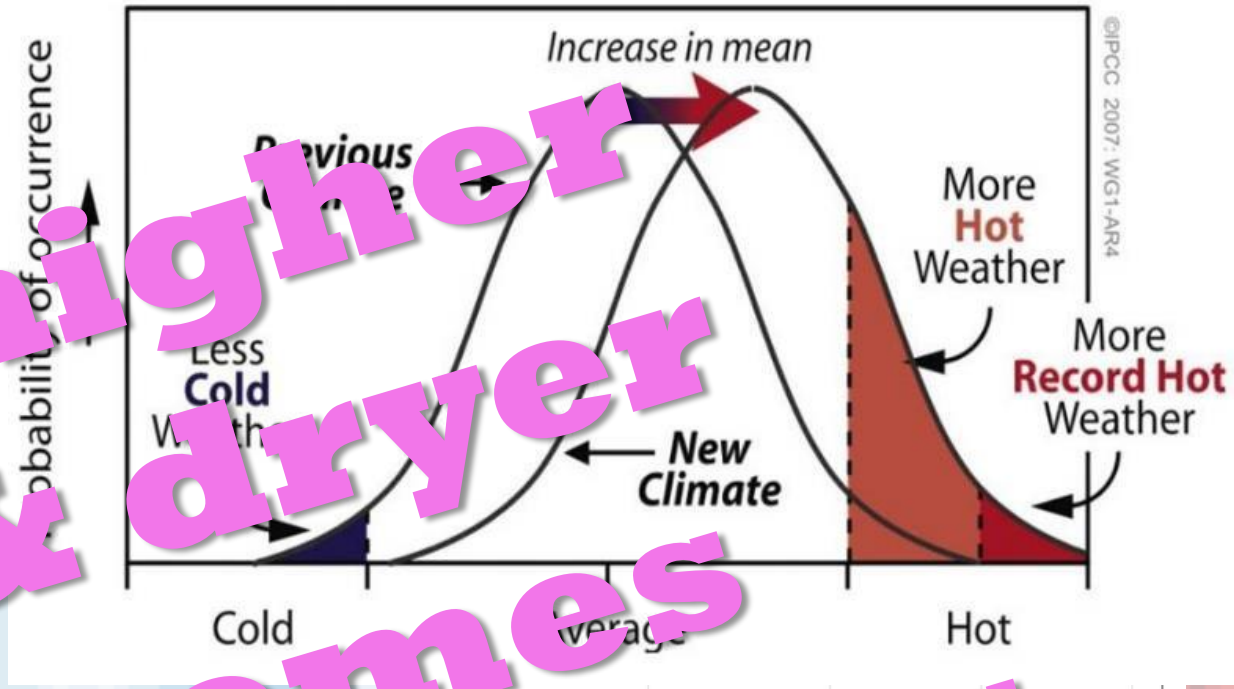
Policy developer Climate adaptation

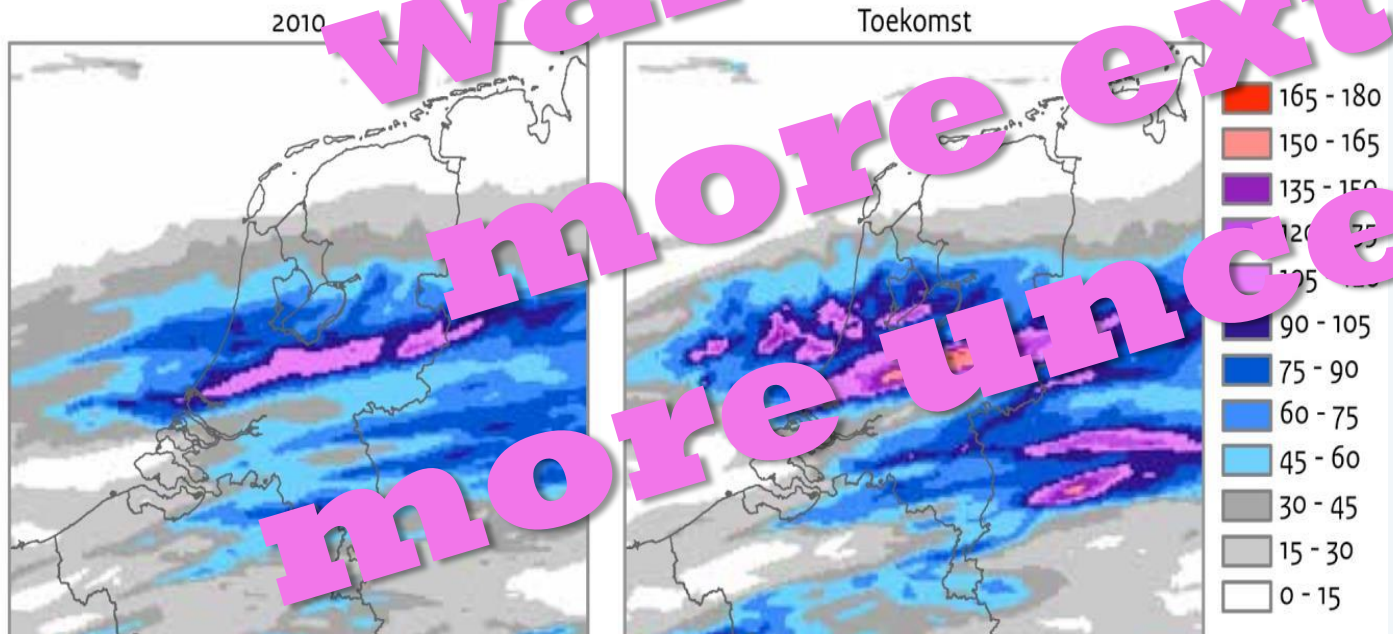
waterschap
amstel gooi en vecht

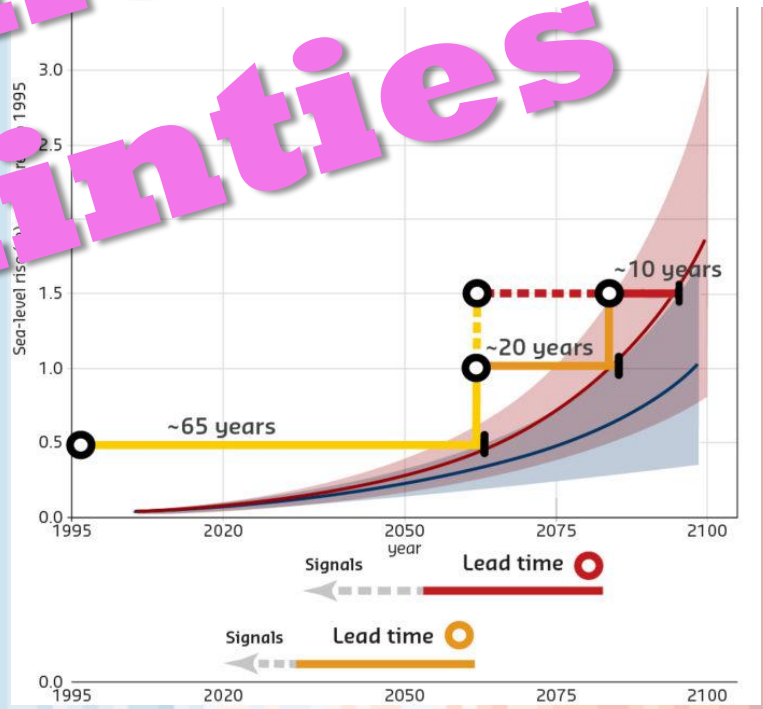


Adapting to climate change

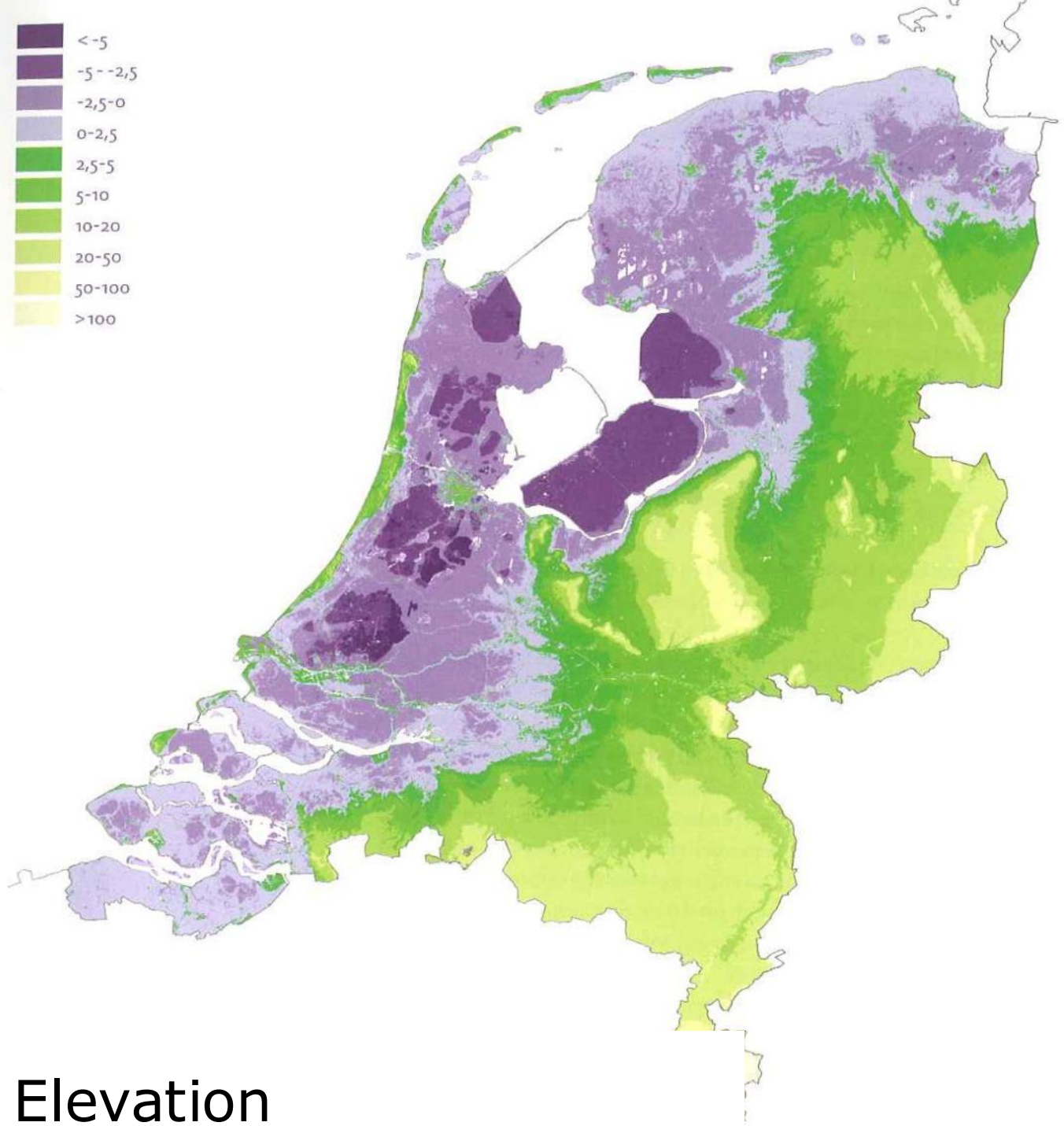
wetter & higher
warmer & dryer
more extremes
more uncertainties





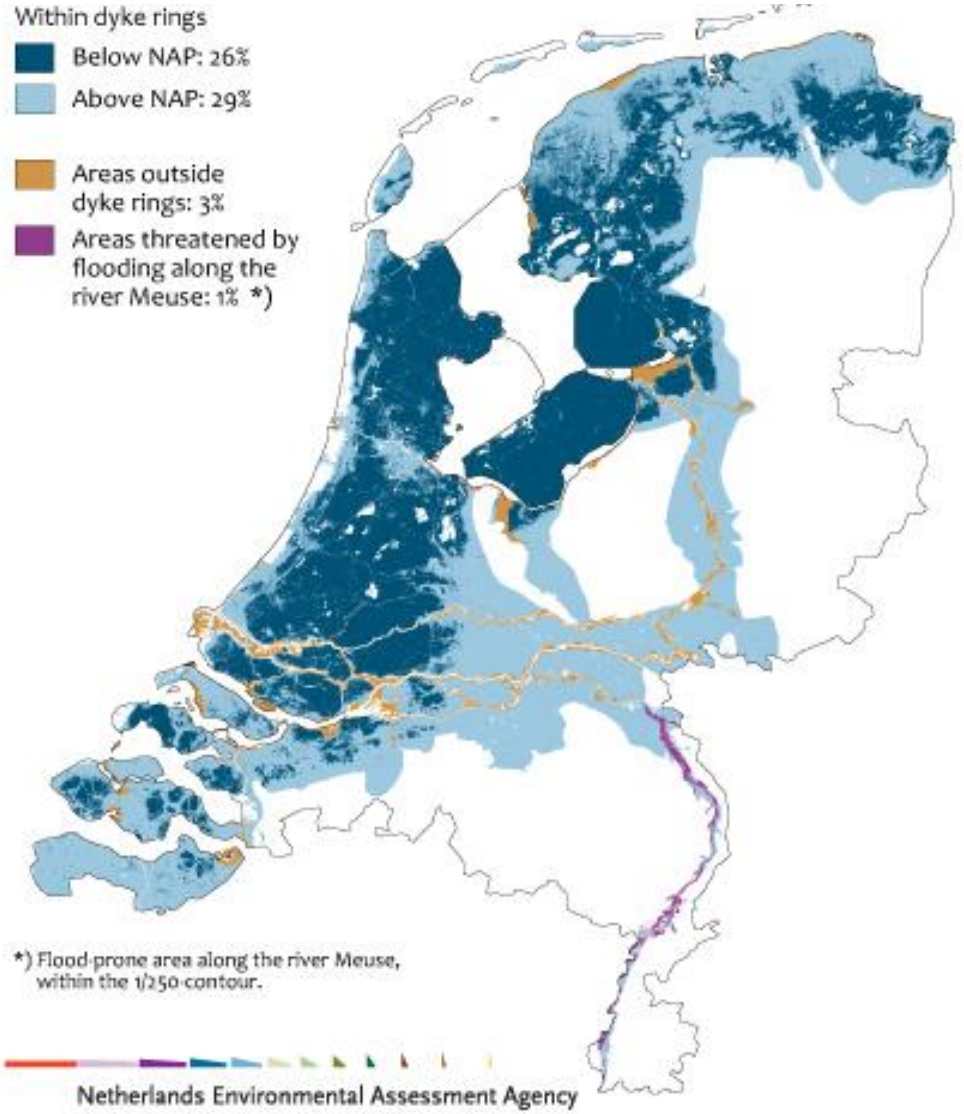


The Netherlands

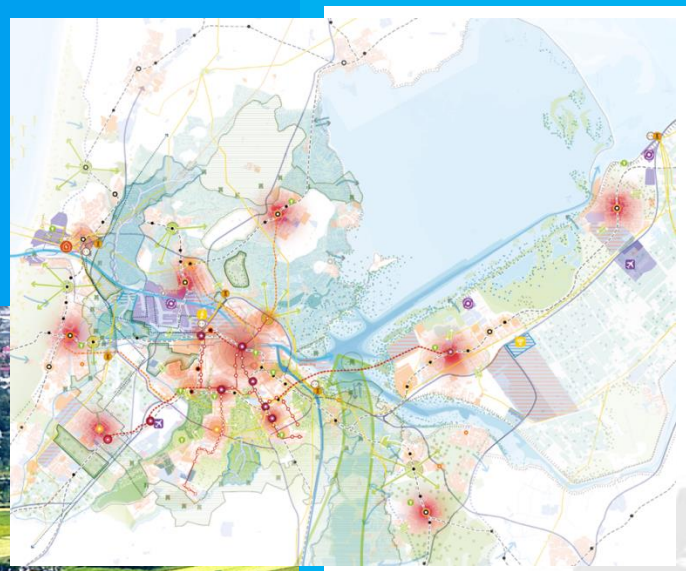


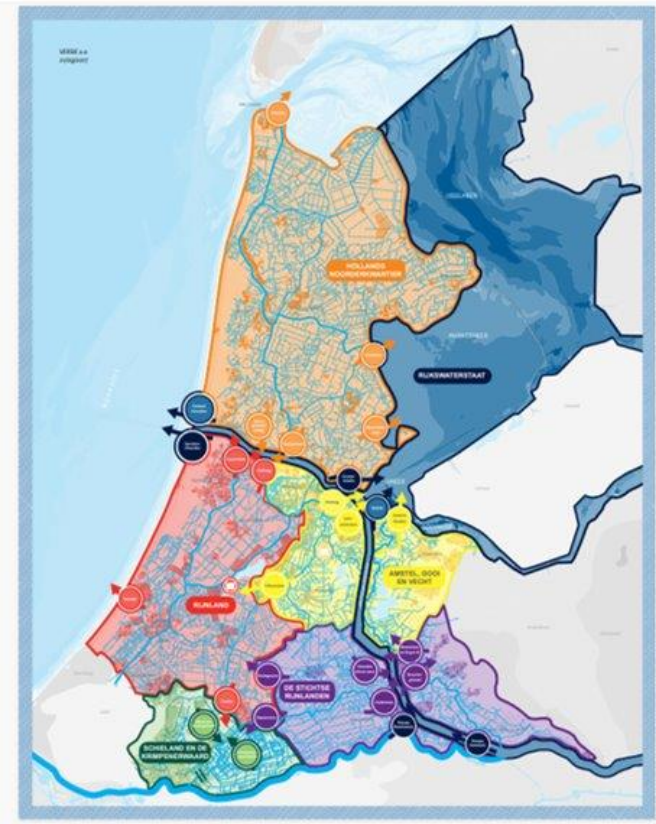
Elevation

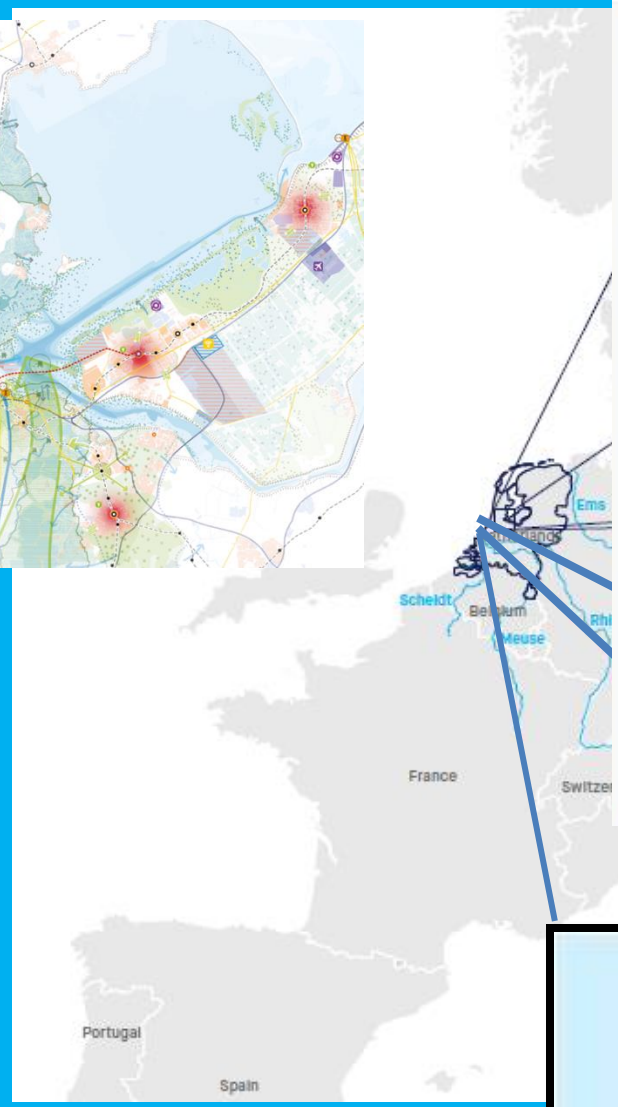
Flood-prone area



Amsterdam Metropolitan Area (AMA / MRA)







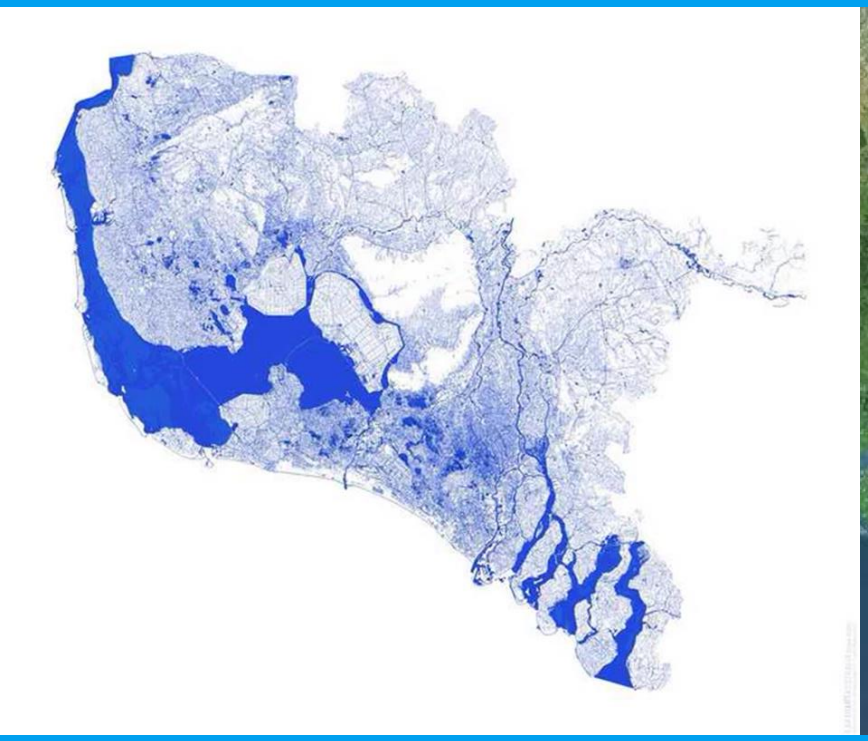
- 2 provinces
- 30 municipalities
- Transport Authority Amsterdam
- 4 water authorities

Tilting the map (Dutch Delta)

18 million people

1/3 = 9 million people under sealevel

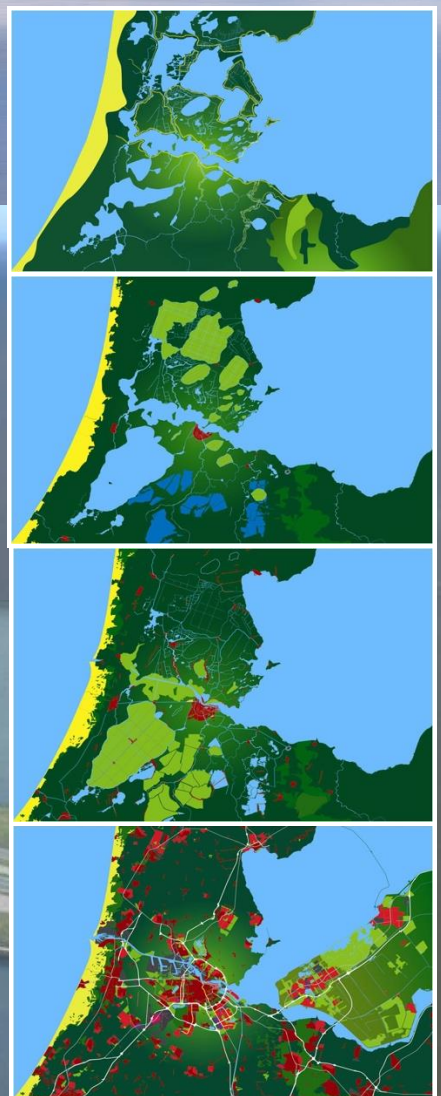
2/3 of our BNP



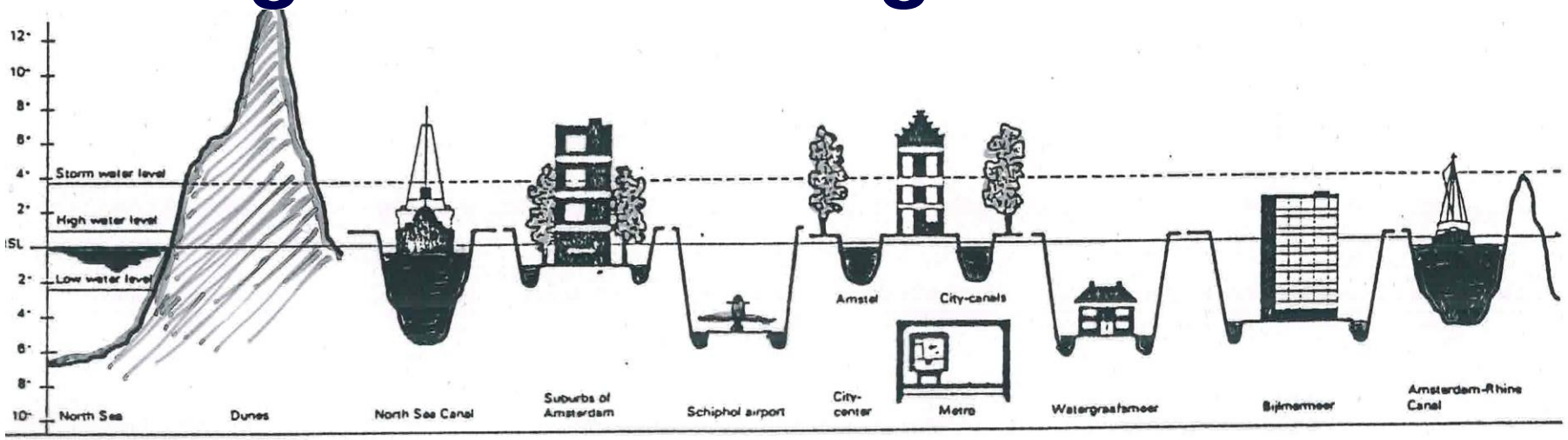
Traditional public water management

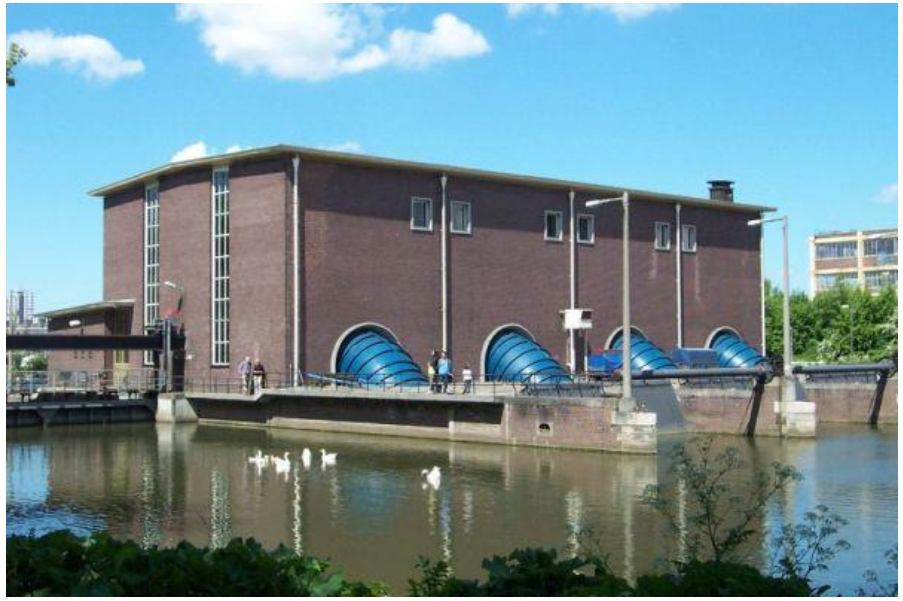
Since 1255 !

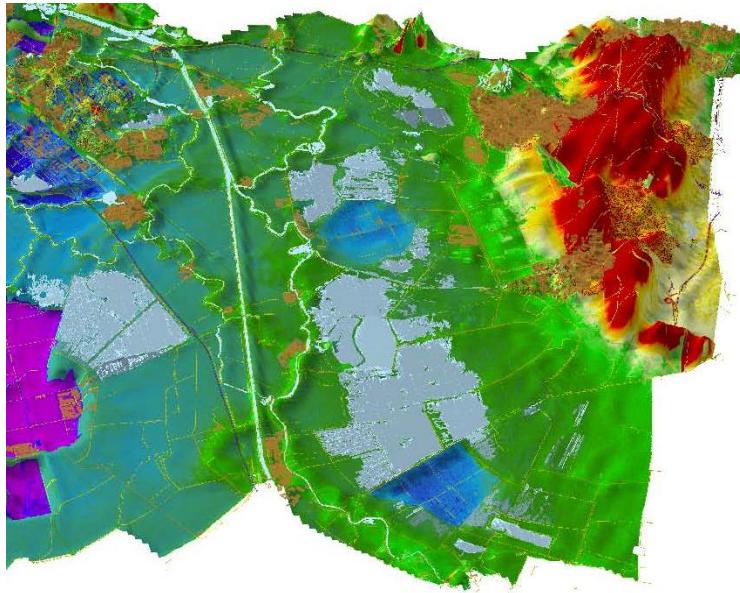
Dikes, pumps, sluices and surge barriers



Water management in a region below sealevel







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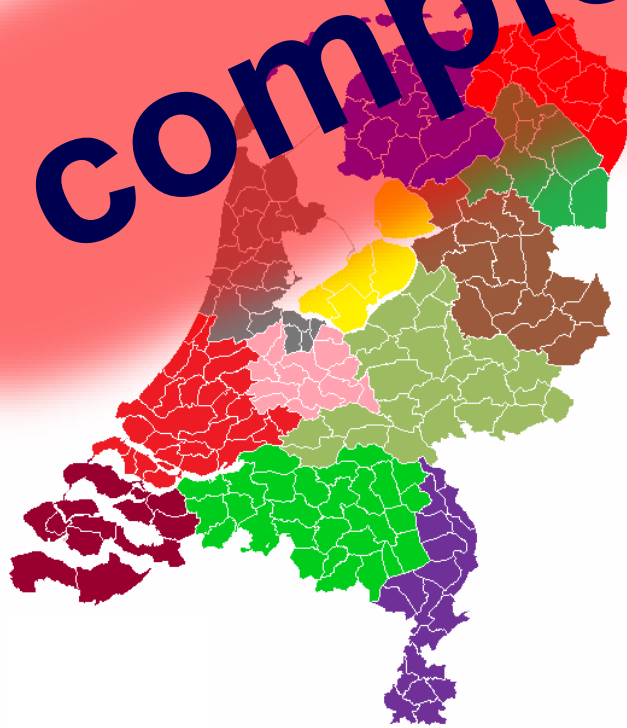
Water governance in The Netherlands



complex

21 Water boards

10 Drinking water supply companies

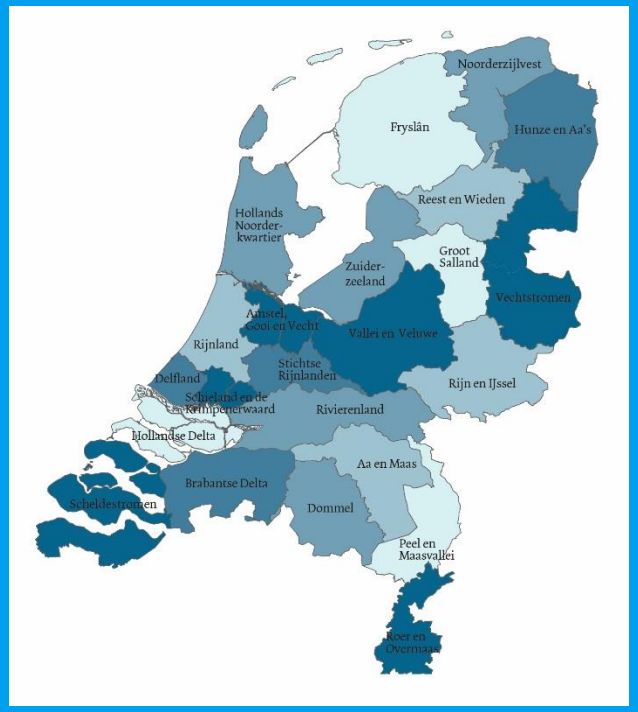
12 Provincial authorities and 342 Local authorities

waternet
waterschap amstel gooi en vecht
gemeente amsterdam

+ *National legislation and directives*
+ *European legislation*

Distributed and layered responsibilities
Functional and general democracy
European - National – Provincial - Regional - Municipal

Merging in the water sector

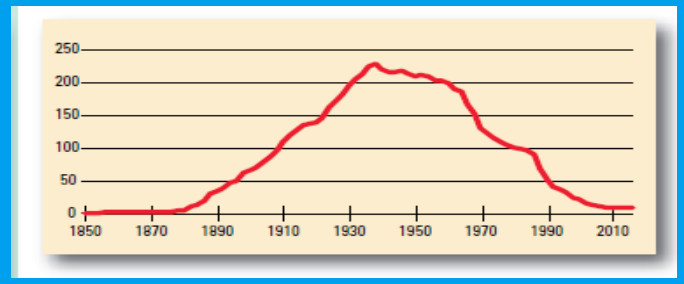


21 regional water authorities

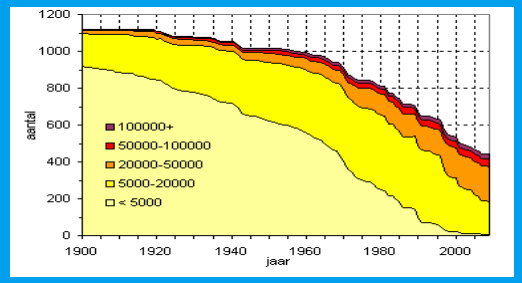
10 drinking water companies

342 municipalities

1950: 2600 regional water boards



1935: > 200 drinking water companies



1900 >1100 municipalities

OESO-study 2014

The Netherlands has an excellent track record:

- Sophisticated coherence between technical and na
- Robust and adaptive institutions
- Flexible and evolv
- Obvious in
- Sustainable f ing instruments

lack of water awareness

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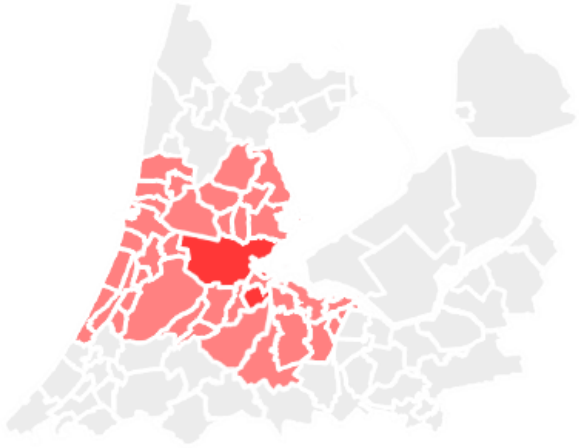
OECD

Sectoral regional collaborations & stress

DPRA Werkregio Amsterdam

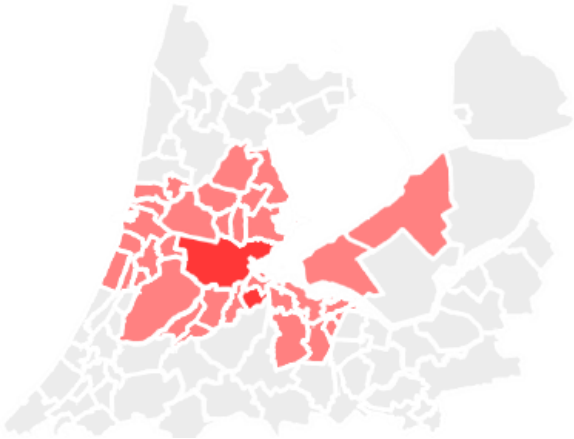
Deltaprogramma Centraal-Holland



NOVEX Noordzeekanaalgebied

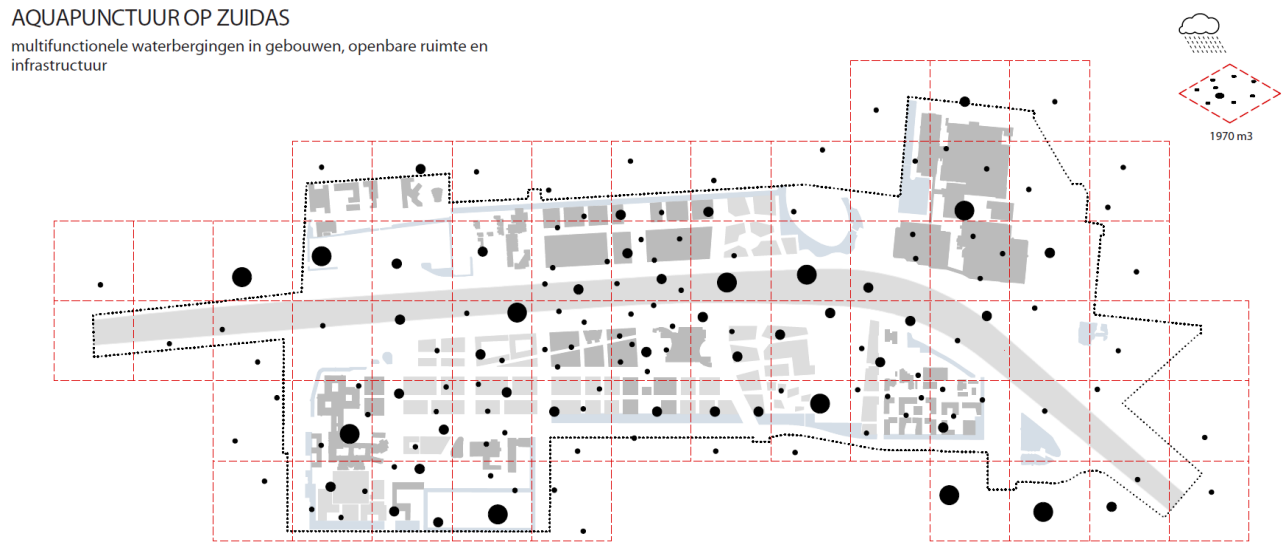
NOVEX Groene hart

NOVEX MRA & Metropoolregio Amsterdam



Modern water management

- Right water (quality and quantity)
- Right place (context and functions)
- Right time



Retain, retain, re-use

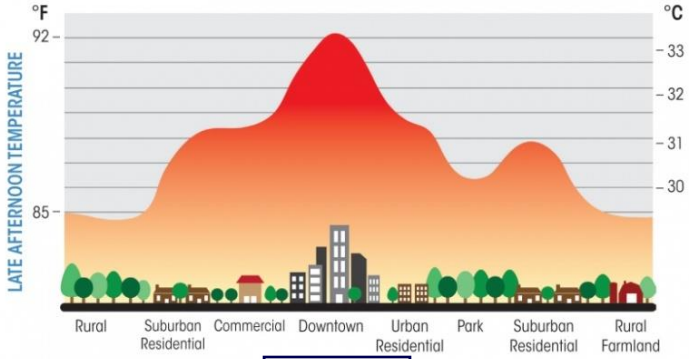
- Small scale and finely meshed solutions:

Sponge City, BGI, Aquapuncture & Micro water management

Amsterdam Rainproof

National Delta Program - Scope Deltaplan Spatial Adaptation

Waterlogging



Heat

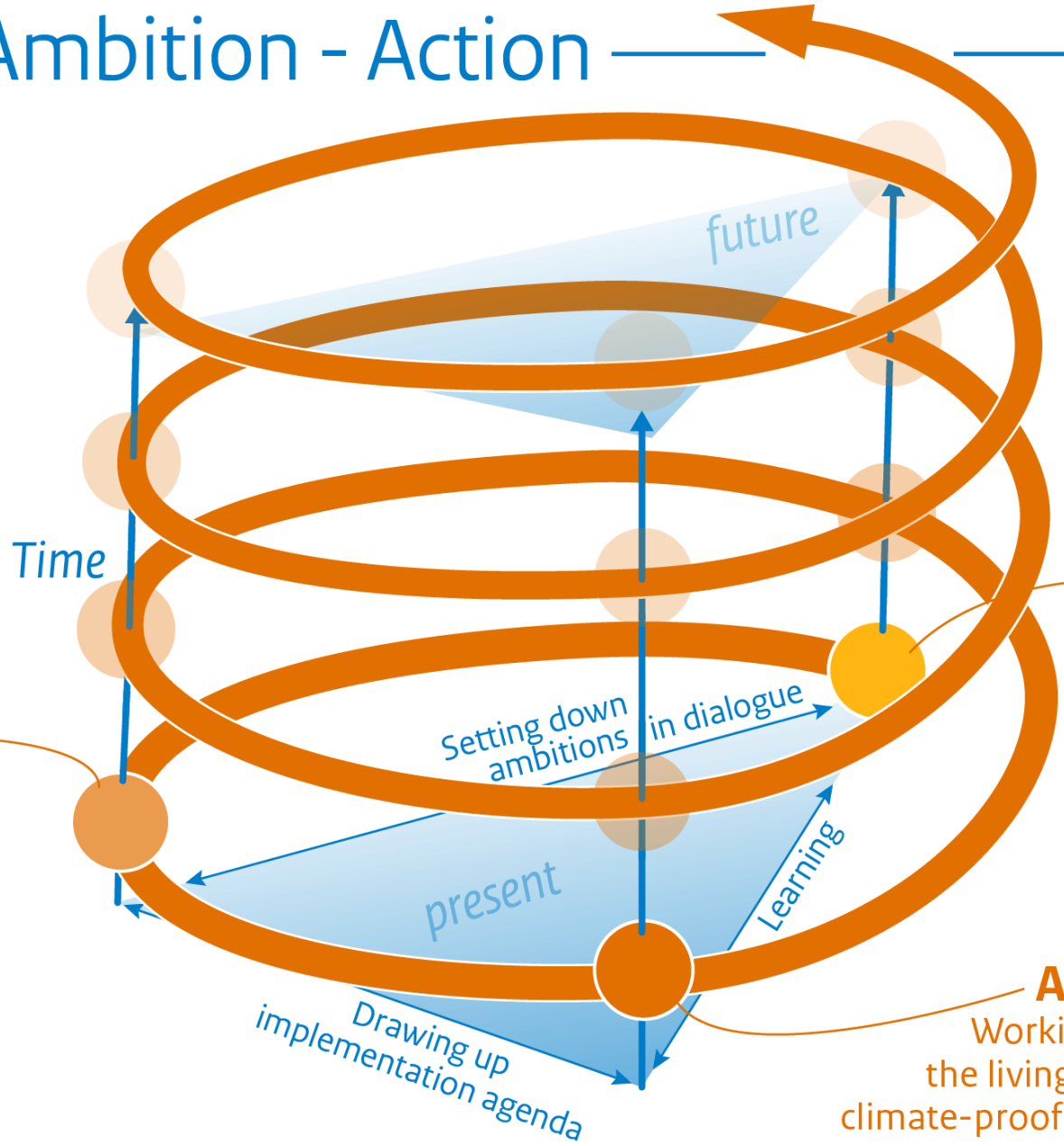
Flooding

Drought

7 ambitions

Water-resilient and climate-proof spatial planning in the Netherlands

Analysis - Ambition - Action



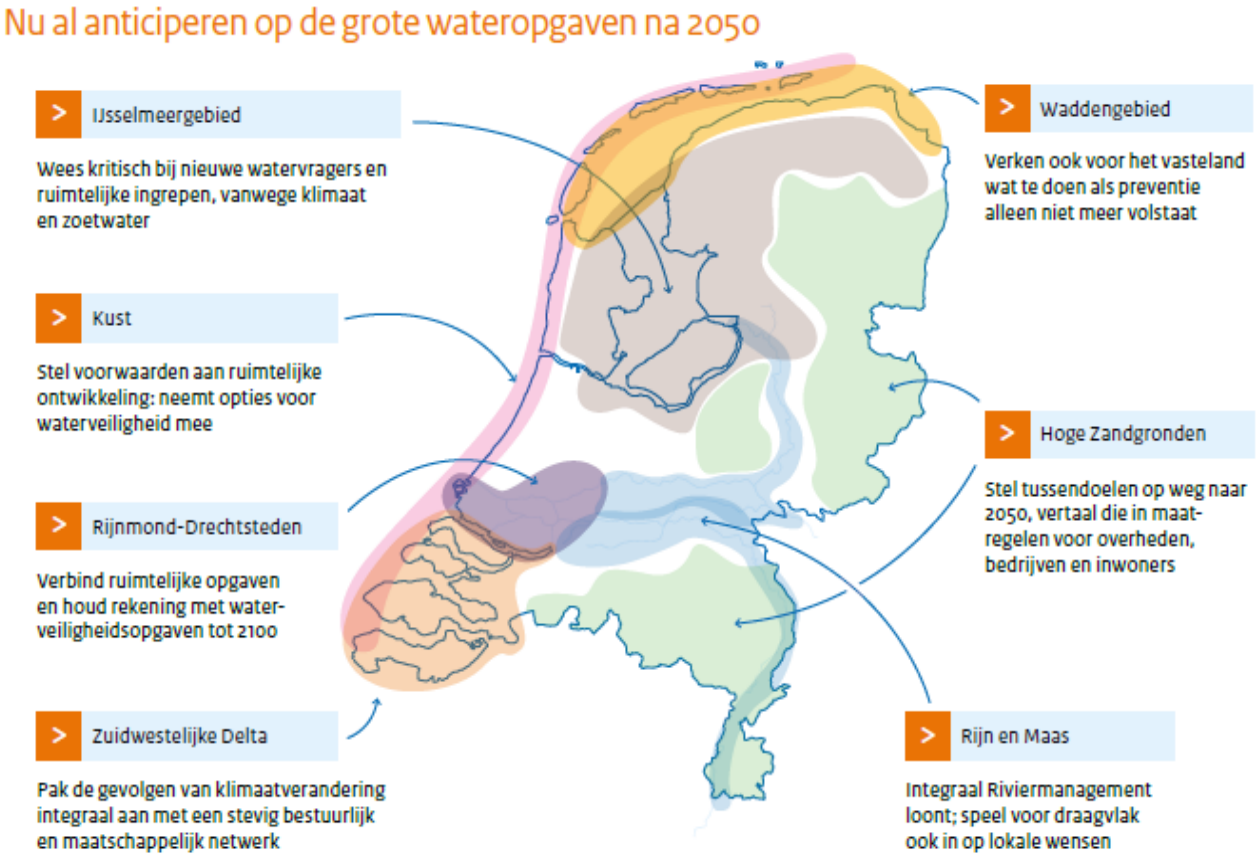
Analysis
Analysis of vulnerabilities and opportunities

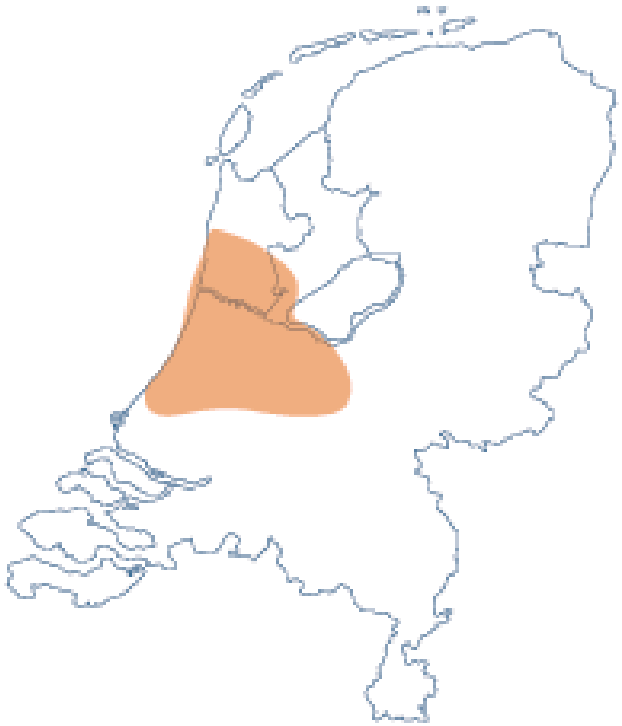
Ambition
Formulating strategies

Action
Working to make the living environment climate-proof and water-resilient

Methodology of the long-term and systematic address of water logging, heat stress, drought, and the impact of coastal and urban flooding

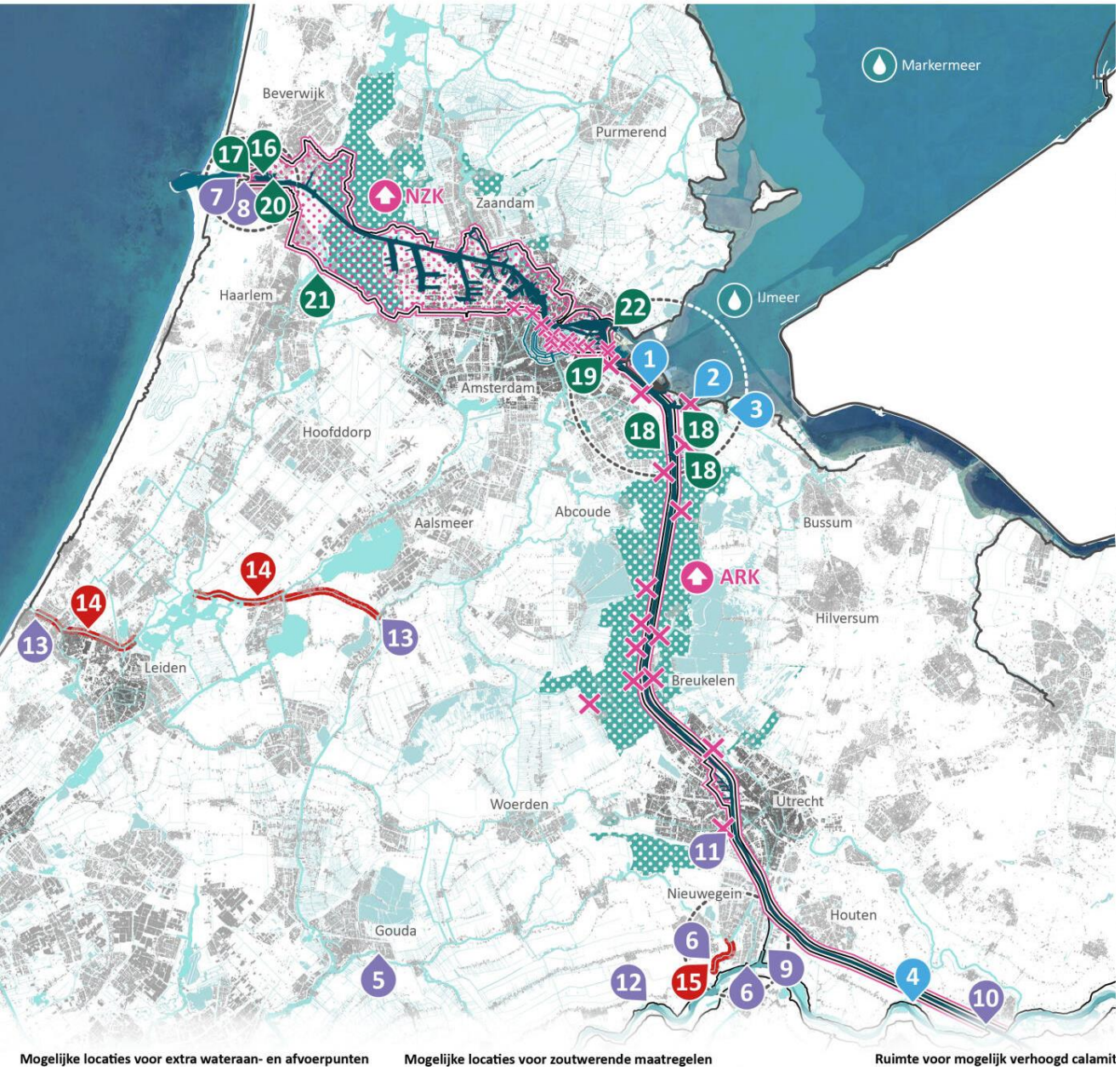
Centraal Holland new area in National Delta program since 2024





Figuur 12 *Belangrijkste opgaven gebieden Deltaprogramma in vogelvlucht*

Noordzeekanaal - IJ - Amsterdam-Rijnkanaal

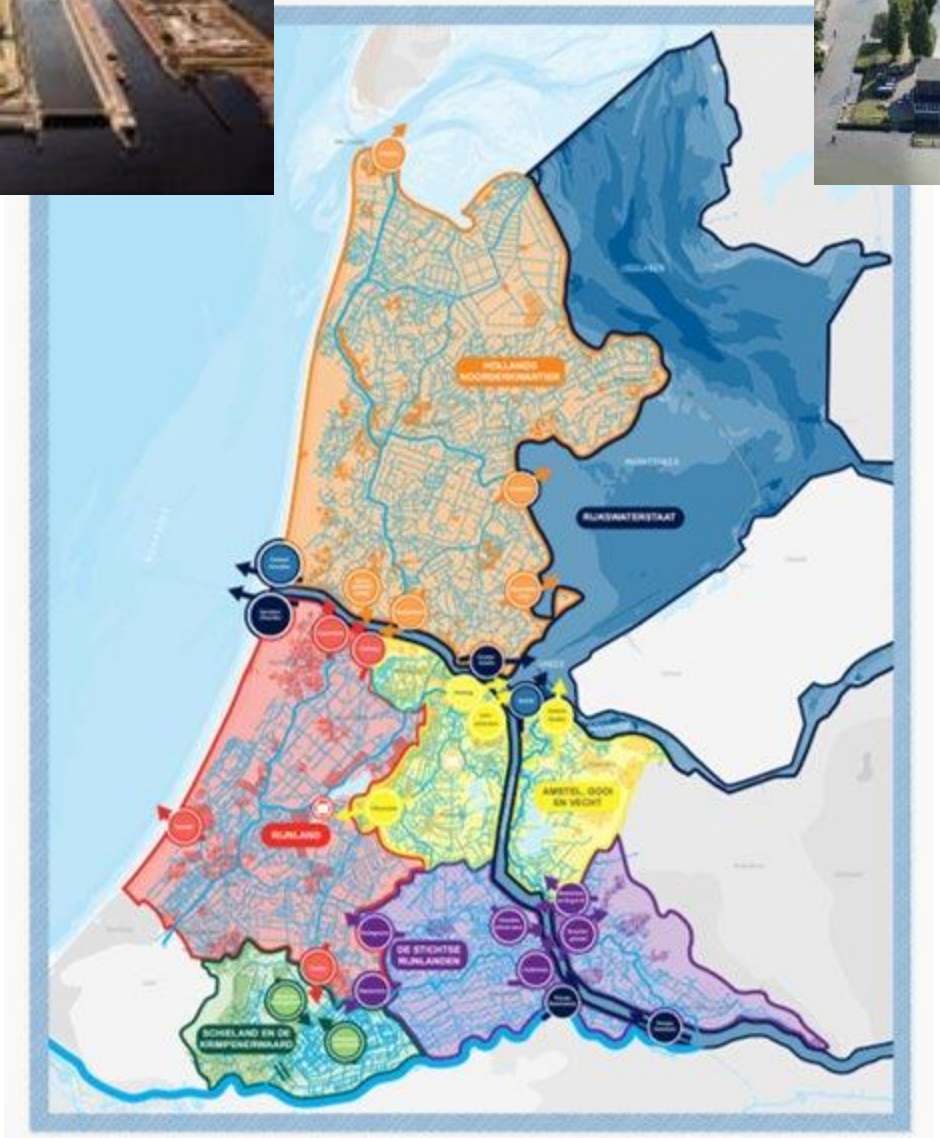


+ ARK-NZK is umbilical cord with direct relations to Lek, Noordzee and IJsselmeer

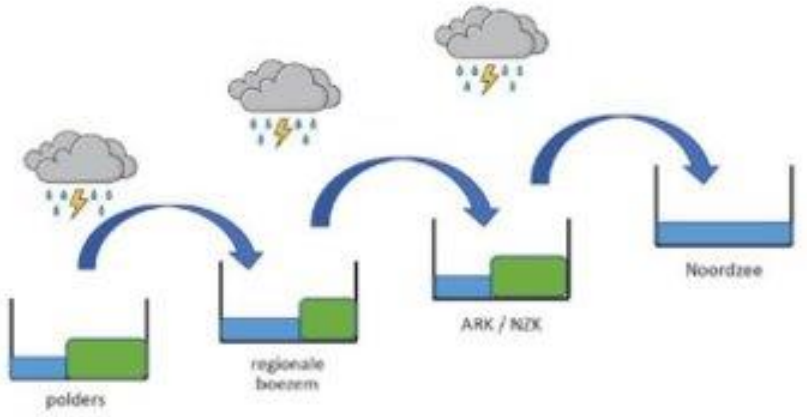
+ Gravitational discharge/pump IJmuiden main route excess water

+ Thin margins waterlevel ARK-NZK: 10 cm -> wafer-thin layer of water is inadequate buffer in the event of excess water

+ From 2050 more vulnerable (no gravitational discharge) due to SLR



Stressed under extreme large scale rainfall



Afvoer is beperkt: meer afvoeren dan de maximale afvoercapaciteit kan niet.

Ilet regent soms harder dan uit het gebied kan worden afgevoerd.

Overtollig water moet dan in het systeer worden geborgen. Dat kan door:
- Stijging waterpeilen
- Bergingsgebieden

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NZK-IJ-ARK-system: Fresh water dependency

Intake freshwater

Discharge and pump capacity IJmuiden

· ARK

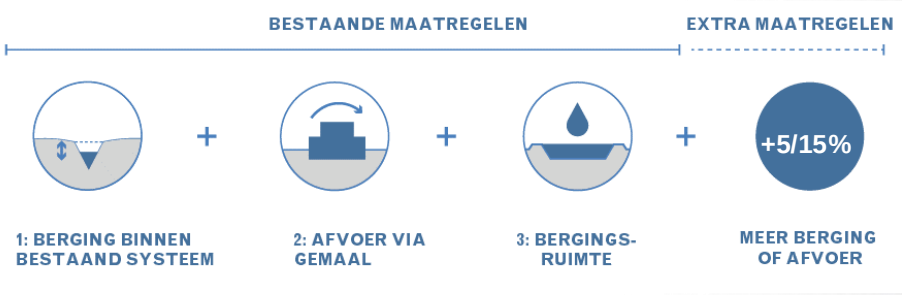
Salinization through shipping and climate

Drought

Raising freshwater demand, dropping availability

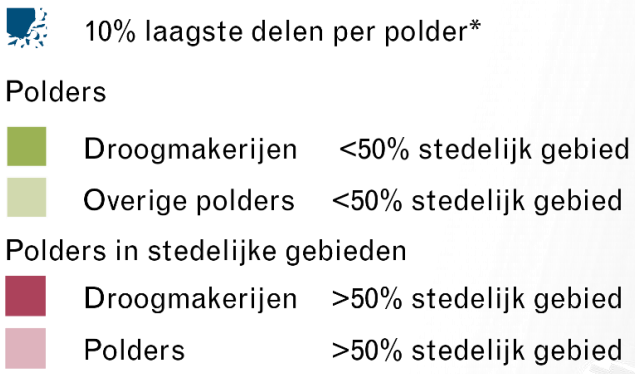
Damage through soil subsidence

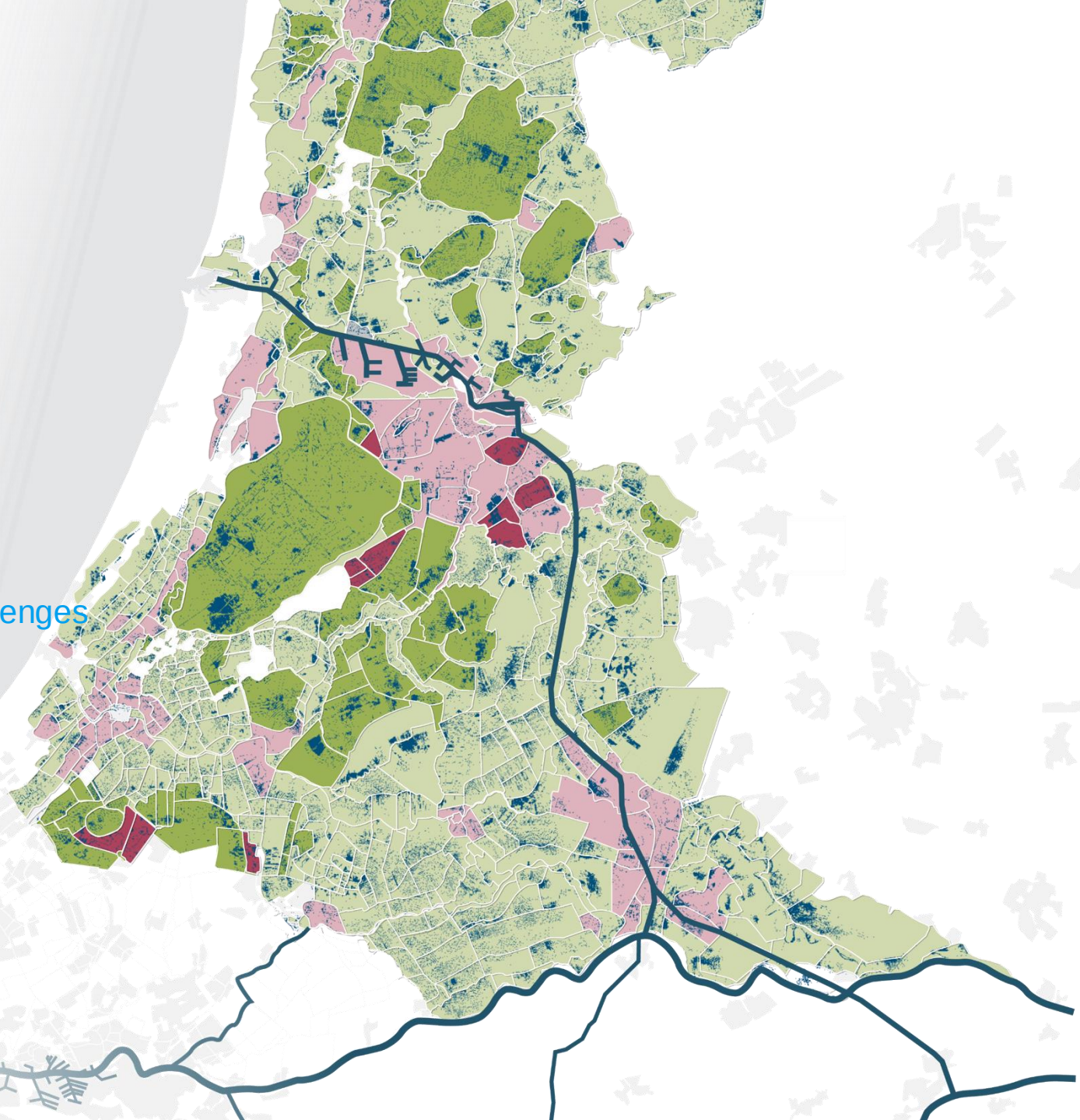
Spatial measures flooding
Poldersystem



- Every polder needs additional storage capacity

- Low lying areas are not always preferred, localized challenges





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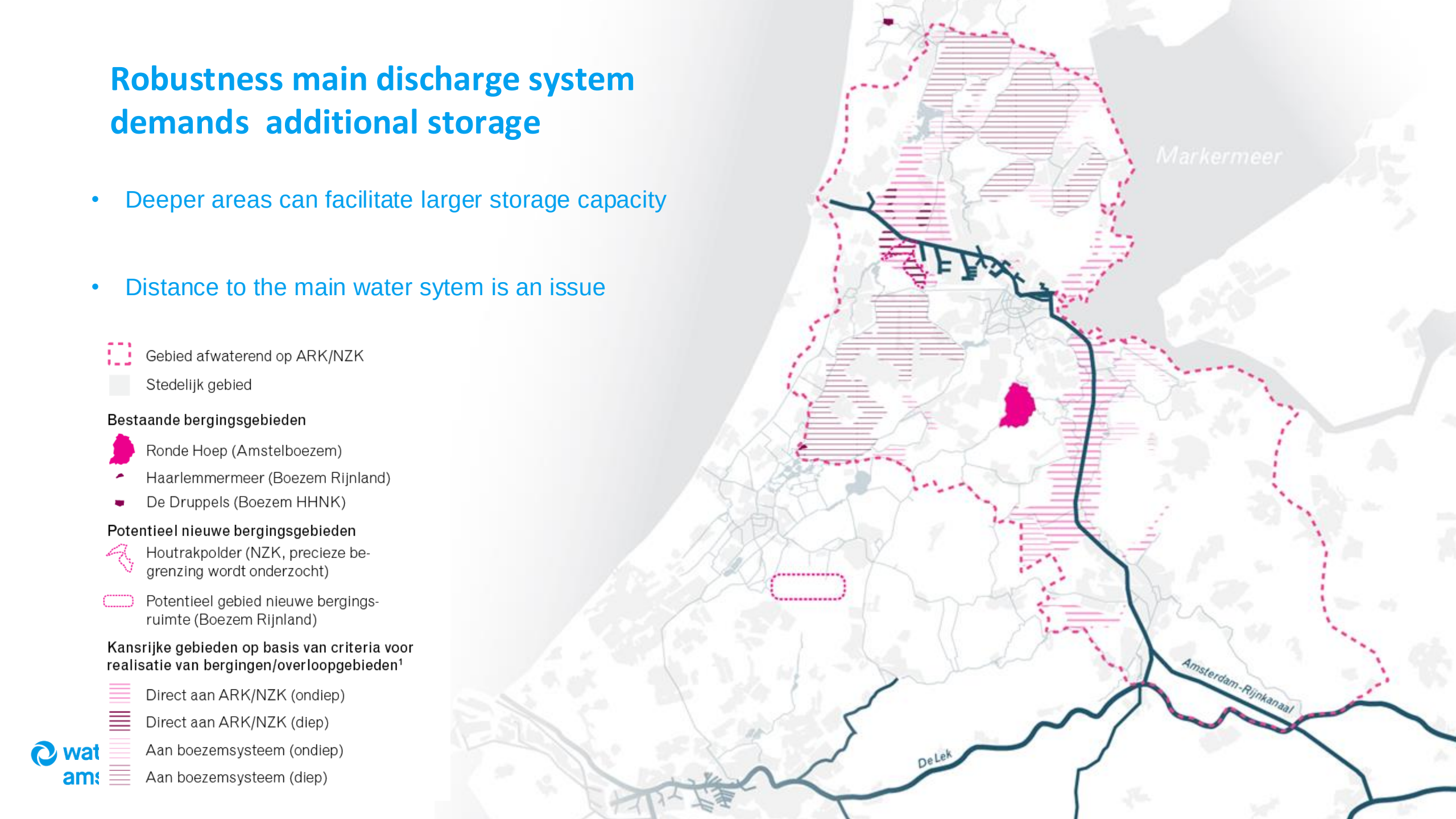
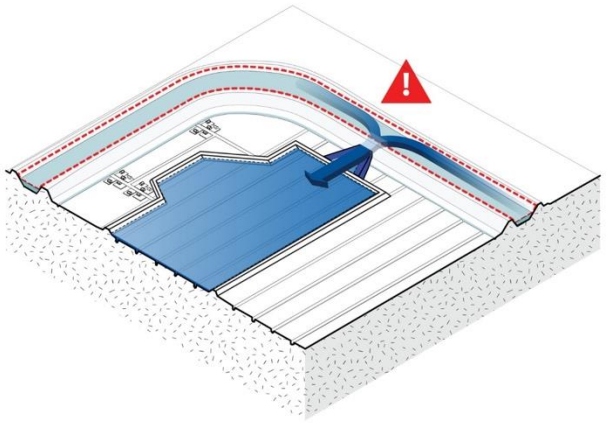
Robustness main discharge system demands additional storage

- Deeper areas can facilitate larger storage capacity
- Distance to the main water sytem is an issue

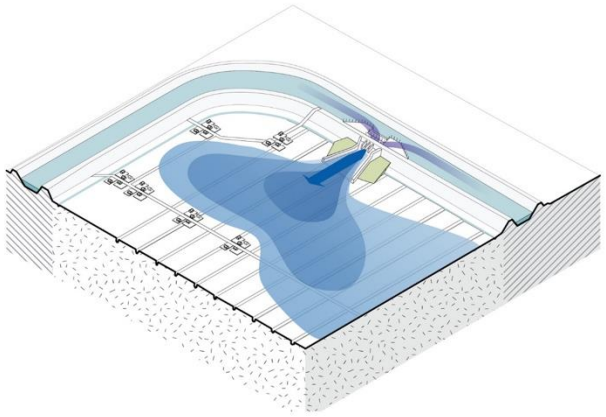


Examples of Boezem attached Storage

Haarlemmermeer
‘Peak storage’



Ronde Hoep
‘Emergency overflow area’



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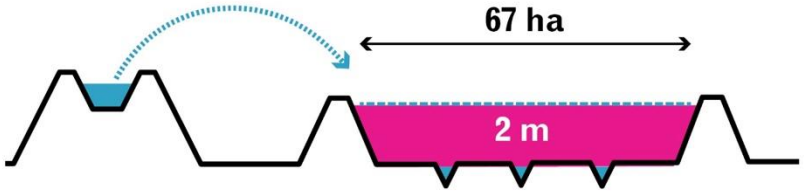
Examples of Boezem attached Storage

Haarlemmermeer
ca. 1/15 year

Ronde Hoep
ca. 1/100 year

Examples of Boezem attached Storage

Haarlemmermeer

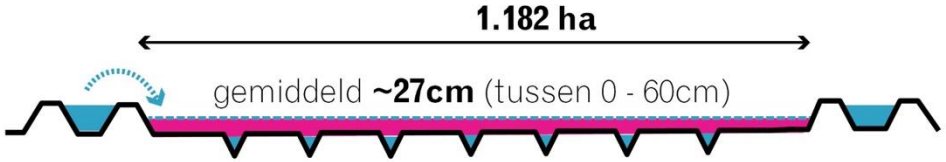


12 m³/s (24 uur gevuld)

1 miljoen m³

- Compact and deep
- Low frequency
- Co-functions: extensive agricultural, nature
- Ownership: acquired

Ronde Hoep



28 m³/s (24 uur gevuld)

2.4 miljoen m³

- Spacious and shallow
- Very low frequency
- Co-functions: extensive agricultural, nature
- Ownership: unchanged

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Ronde Hoep

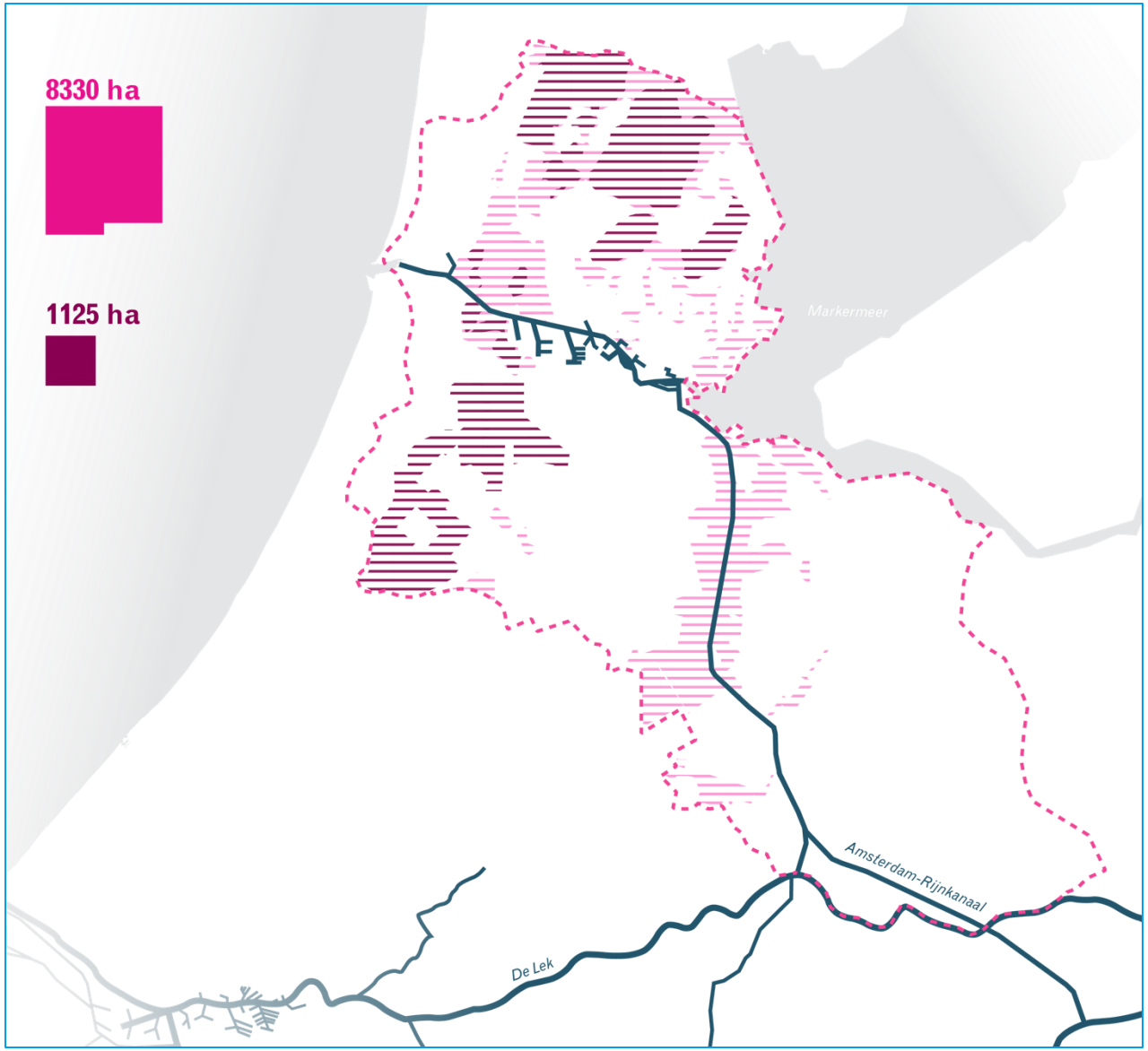
9 x storage capacity

= 8330 ha

Haarlemmermeer

22,5 x storage capacity

= 1125 ha



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Stacking of challenges:
- Every polder has a storage task

1. Polders along NZK: peak storage task + retention task

2. Polders with salinization: retention task + saline seepage task: measures such as flexible water level management can limit retention capacity.

3. Deeper polders in Vecht lake area: seepage from surrounding peat and lake areas

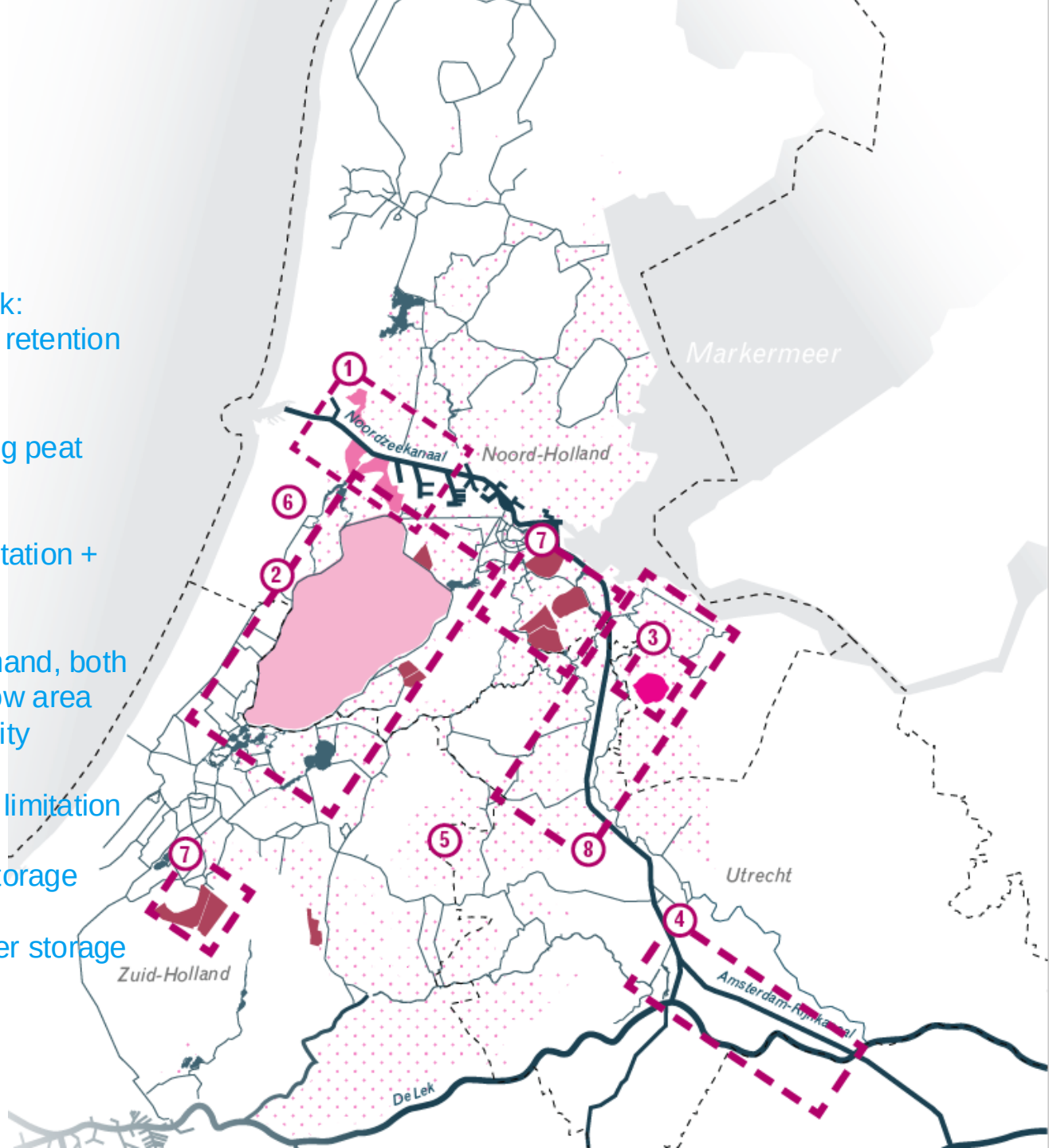
4. ARK/Lek: possibly major infrastructural task extra pumping station + supply/discharge canal between ARK and Lek

5. Peat land: dilemma preventing soil subsidence vs water demand, both inner-city (due to foundation damage) and in the peat meadow area (due to peat oxidation), possible reduction of storage capability

6. Inner dune edge: better use of freshwater seepage, demand limitation

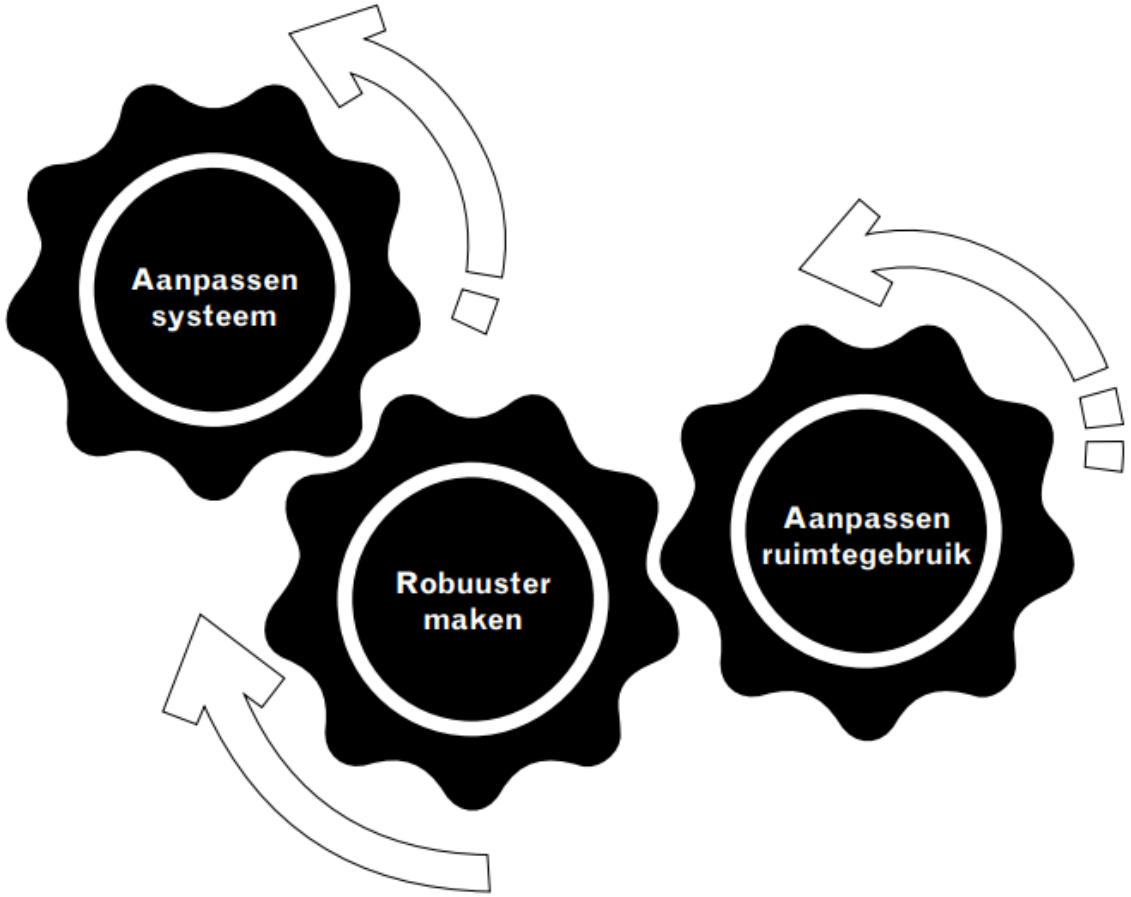
7. Drainage areas with a lot of paving: limited space for extra storage

8. Water storage around ARK: task for decision-making on water storage areas that relieve ARK plays a role in the short term.



Waterchallenges Centraal Holland

Water and spatial planning in the mix (and + and + and + and)



Everything is needed:

- Every city as a sponge
- Every polder has a (spatial) task
- Relieving the Boezem system
- "Airbags" (large-scale water storage) needed
- More drainage options needed for the Main Water System

Water and soil as guiding principles

2022 National policy letter

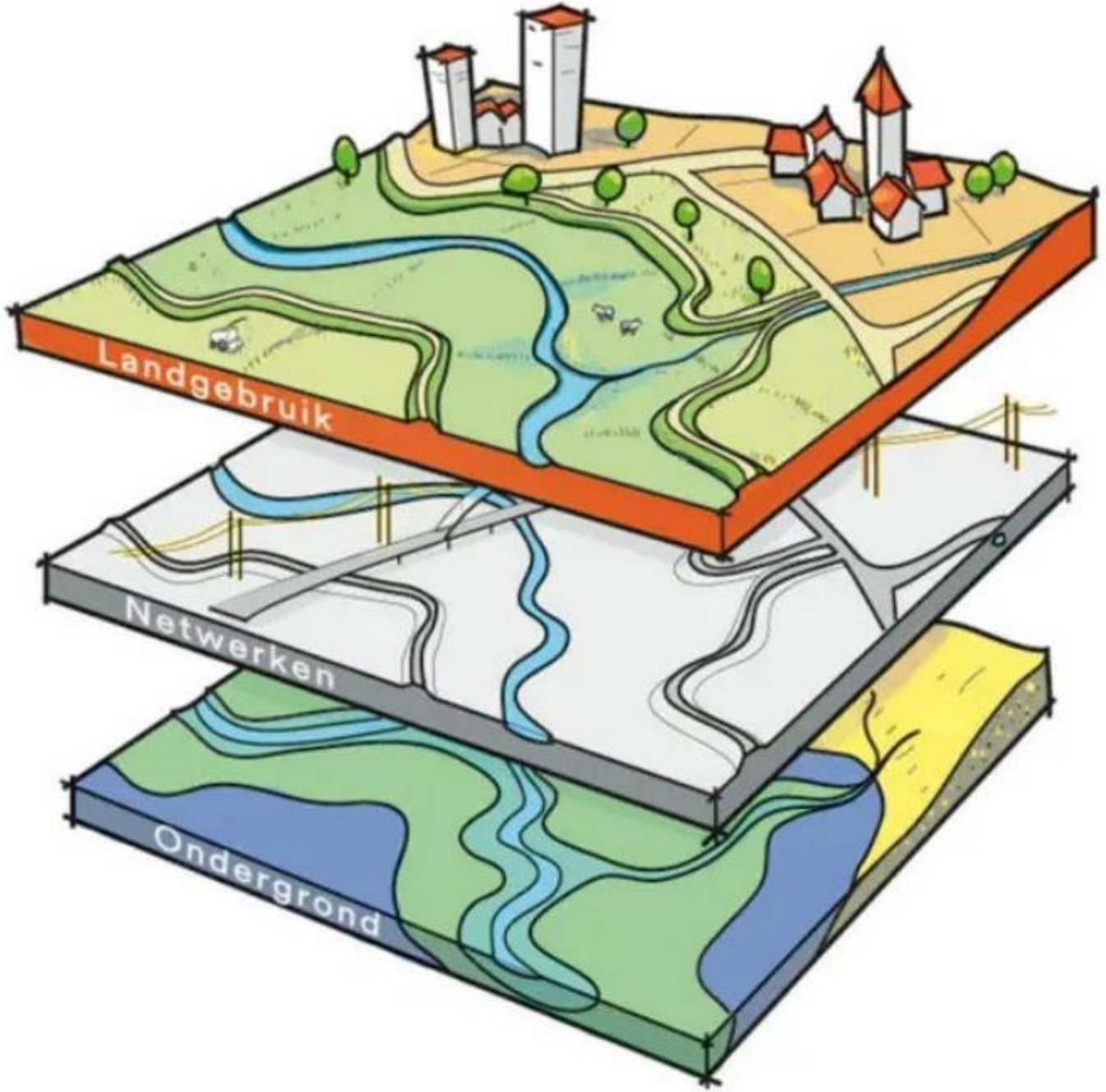
- 9 principles
- 33 structural choices

Essence: ***function follows water***
(instead of water follows function)

no more passing on problems to:

- next generations
- other systems or areas
- from private to public

2024 Ambitions reduced



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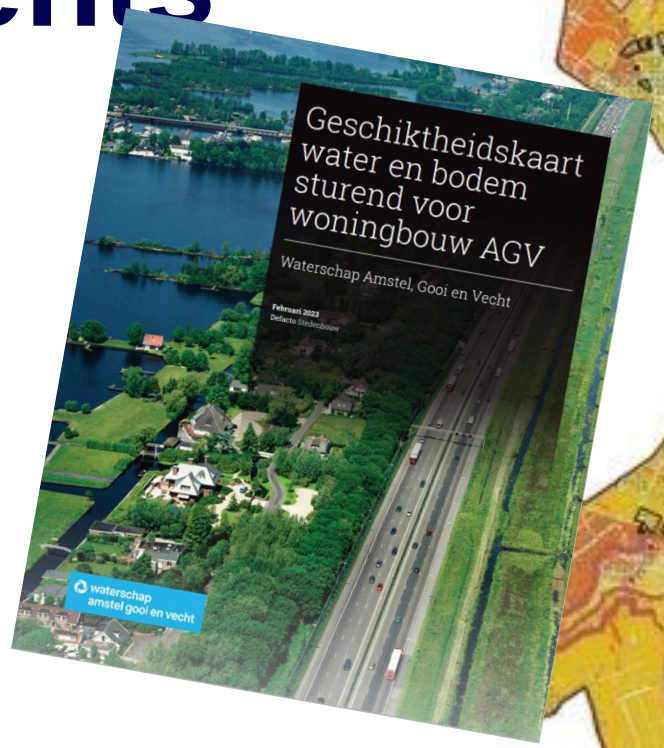
Feasibility map developments



Based on:

- 6 theme maps
- 18 sub maps

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6 Thematic maps

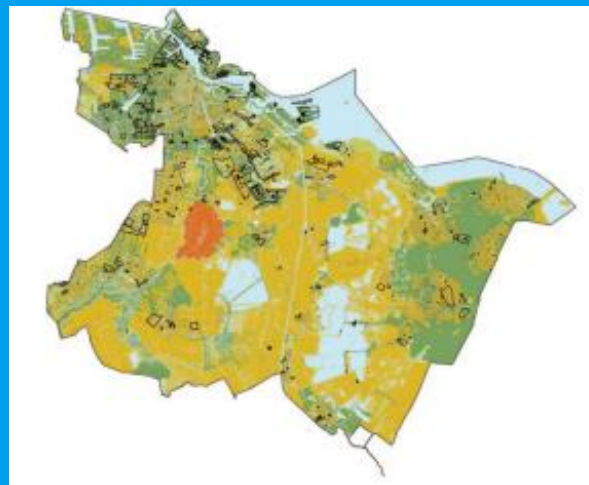
Soil subsidence

(ecological and chemical) water quality

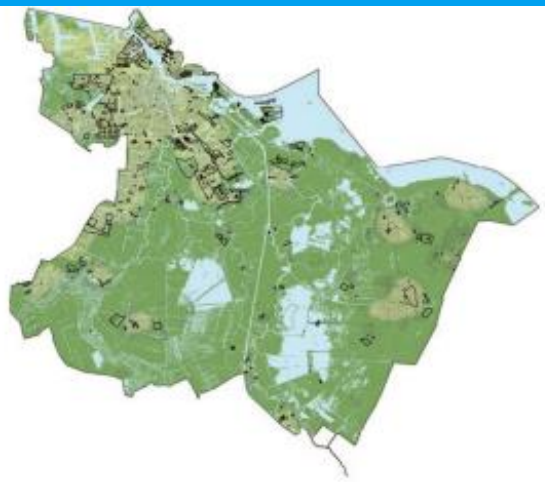
flood risk

drought and sweet wateravailability

- A Geen extra opgave vanuit bodem, water en klimaatverandering (Ja)
- B Bodem, water of klimaatverandering vraagt om aanvullende eisen (Ja, mits)
- C Bodem, water of klimaatverandering vraagt substantiële inspanning (Ja, mits)
- D Een ontwikkeling of landgebruik legt een claim op de toekomst (Nee, tenzij)
- E Ontwikkeling op waterhuishoudkundige infrastructuur is niet wenselijk (Nee)
- Is er een bijzonder aandachtspunt, dan staan er stippen op de kaart

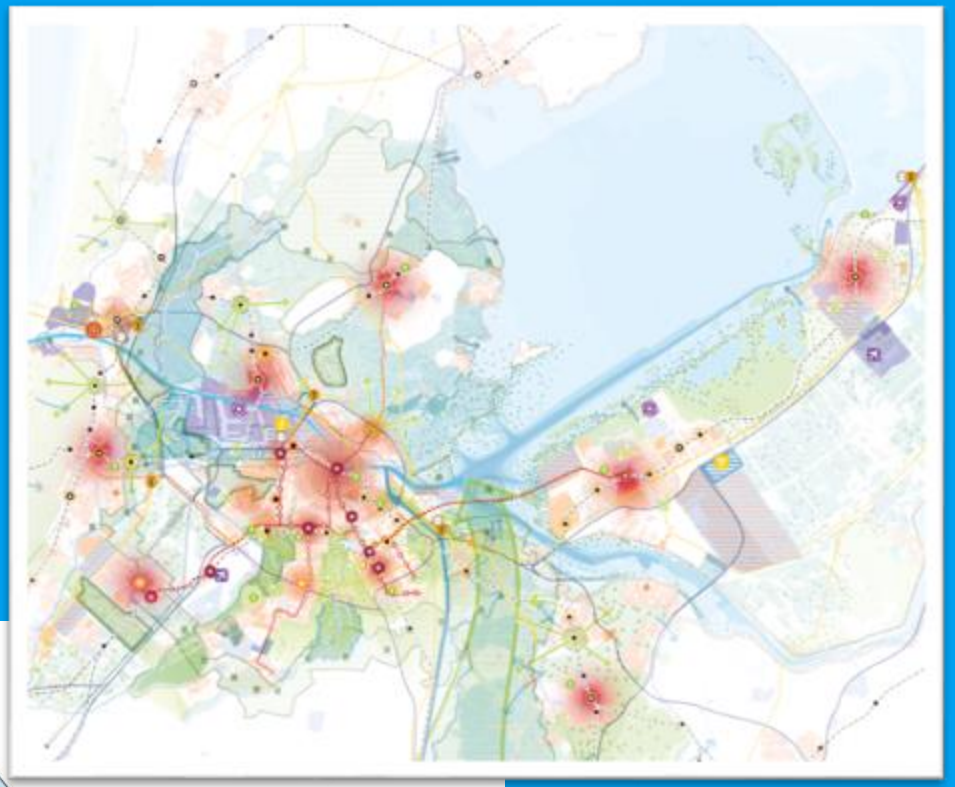


flooding



heat stress

Hot spot / assessment maps development locations



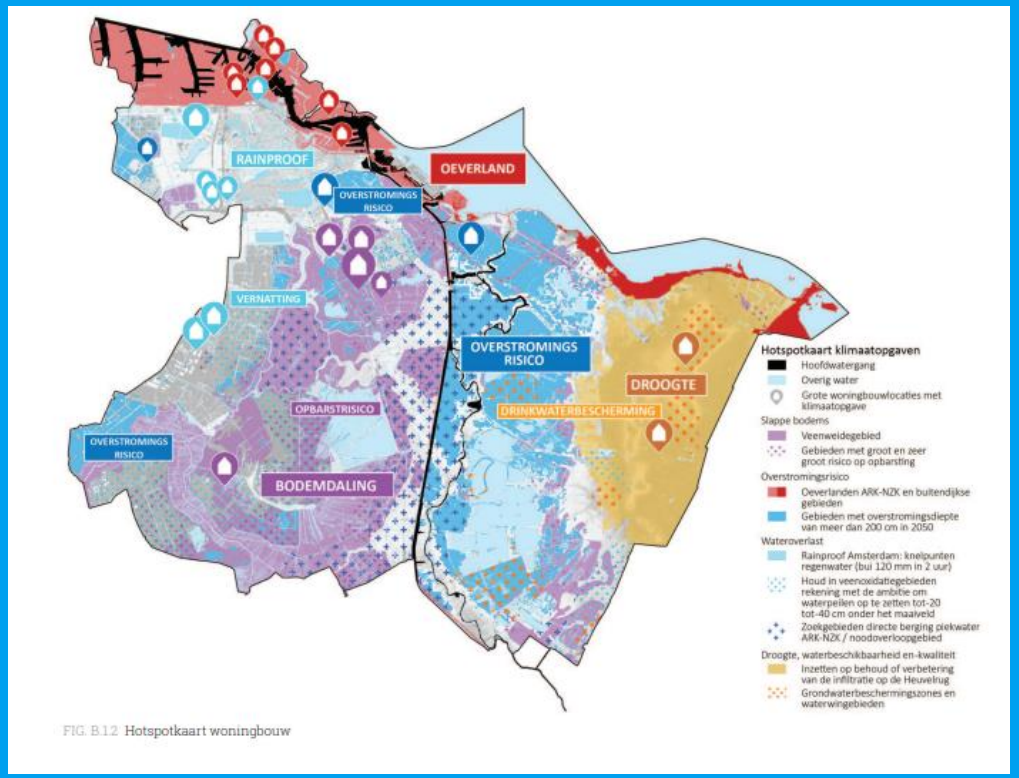


FIG. B.1.2 Hotspotkaart woningbouw

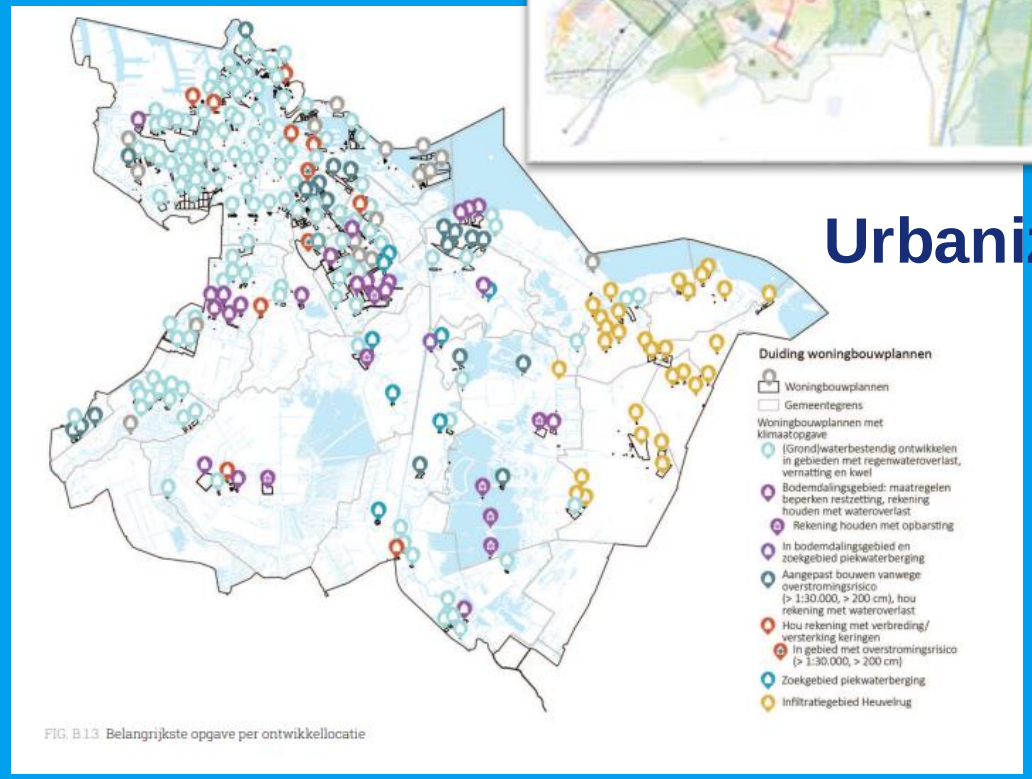
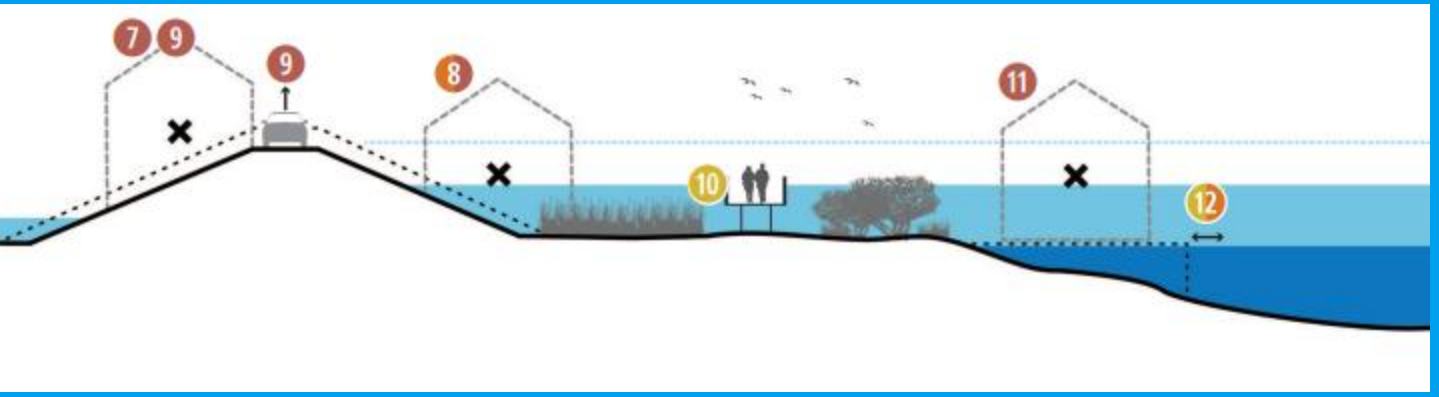
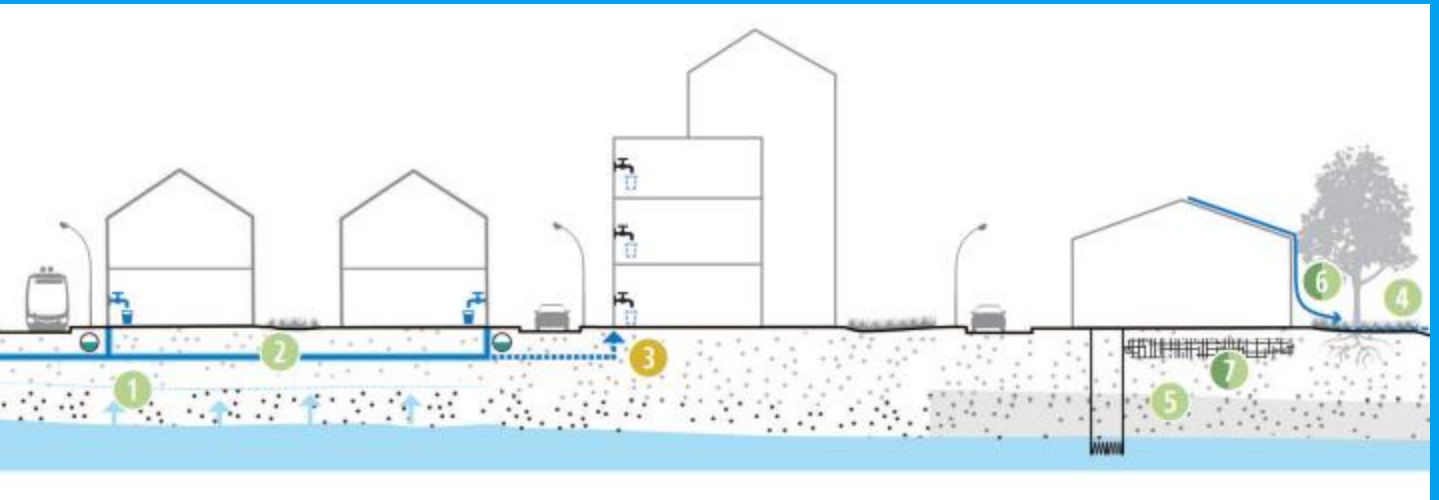


FIG. B.1.3 Belangrijkste opgave per ontwikkellocatie

Urbanization (2050)

Action portfolio





Ontwikkel bodemdalingsbestendig (voorkom afwenteling kosten in bodemdalingsgebieden)

Een gebouwde ontwikkeling in een gebied met sterke bodemdaling of zetting wentelt mogelijk af op de toekomst en het publieke domein (via kosten voor beheer of peilindexatie). Zorg dat er een goede kosten-batenanalyse wordt gemaakt waarin voor de levensduur van de ontwikkeling de haalbaarheid van maatregelen die de restzetting reduceren wordt verkend. Is er geen sluitende businesscase, heroverweeg dan de locatie.

Bodemdalingsbestendig bouwen

8 Zorg voor bouwmethoden die de restzetting beperken zoals een goede fundering, lichte materialen en waterdichte vloeren. C

9 Ontwikkel niet in gebieden met een groot risico op opbarsting of doe dit met innovatieve technieken, zoals drijvend bouwen of bouwen op palen. D E Ook de aanleg van vlakvormige waterbergingen brengt risico's met zich mee.

Bodemdalingsbestendige infrastructuur

10 Fundeer wegen indien nodig I

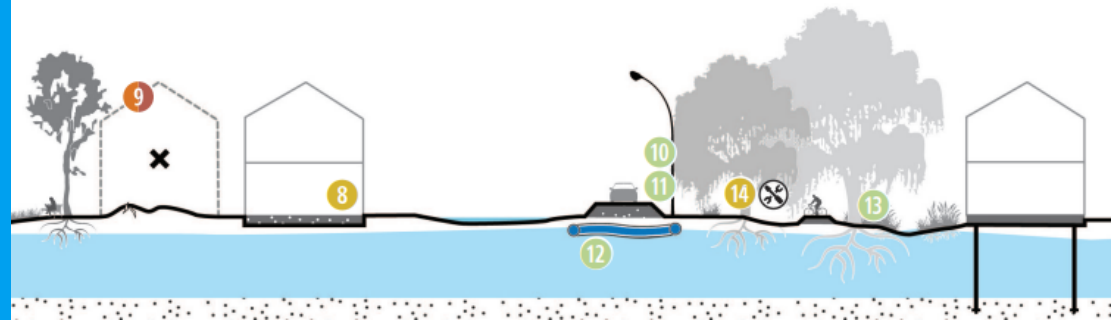
11 Gebruik lichte ophoogmaterialen zoals:
- EPS I
- (lokaal) granulair materiaal I

12 Kies voor bodemdalingsbestendige leidingen:
- flexibele buizen bestaande uit vervormbare materialen I
- versterkte leidingen (drie keer dikker en groter dan normaal) I
- het aanleggen van infiltratiedrains I
- Voorkom zettingsverschillen bij kruisingen van nutsvoorzieningen met waterstaatskundige infrastructuur (zoals duikers).

Meebewegen openbare ruimte

13 Houd in het ontwerp van tuinen en openbare ruimte rekening met bodemdaling en steeds beperktere drooglegging.
- waterrobuuste beplanting I
- waterrobuuste tuinen I
- wateropvanggebieden I
- microhoogtestrategie I
- gefundeerde hogere paden I
- ophoogbare trottoirs I

14 Neem eventuele extra kosten voor beheer en onderhoud mee in de exploitatiekosten (levensloop) C



The Environment and Planning Act

- Since 2024 – replacing 26 laws (decade in the making)
- Decentralisation and regionalisation
- Challenging for young policy field Climate adaptation
- Bottom-up creation of new collaborations
- MRA leading

waterschap
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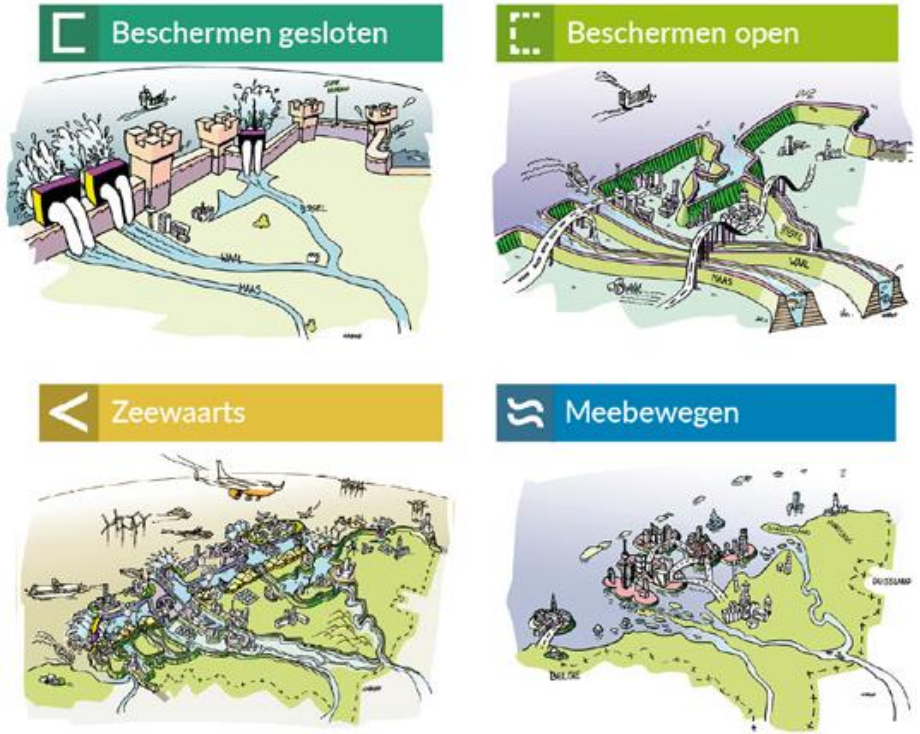
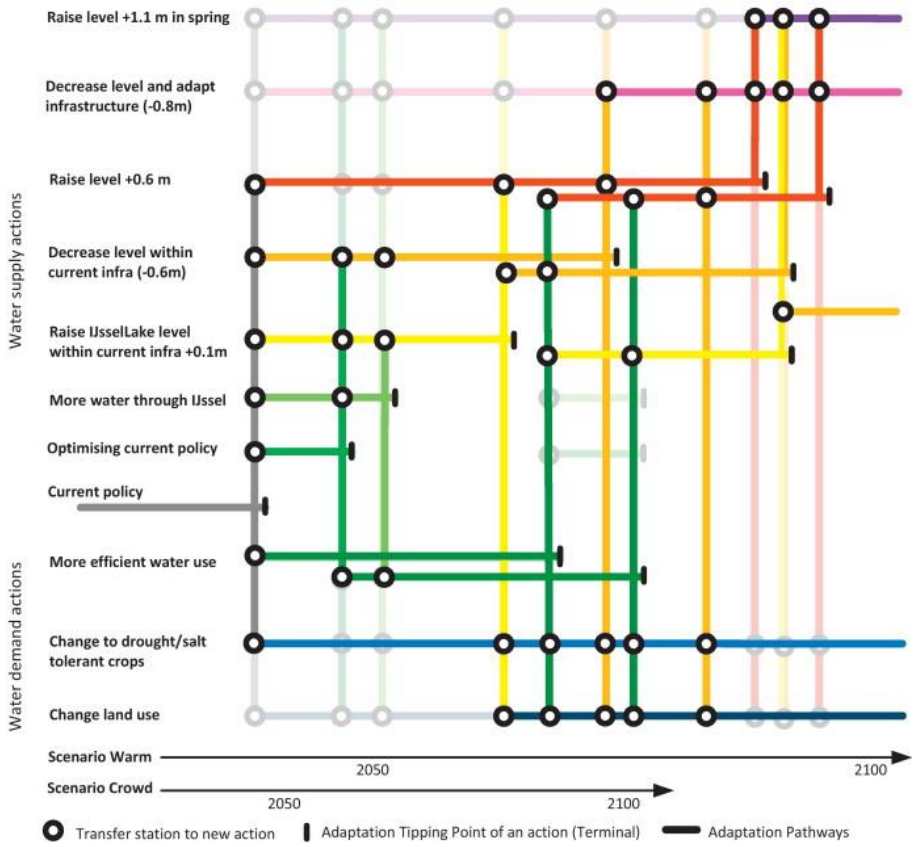
Vision development and backcasting

- Scenario development and adaptive pathways
- Transformative water management
- Spatial transitions en restructuring of NL

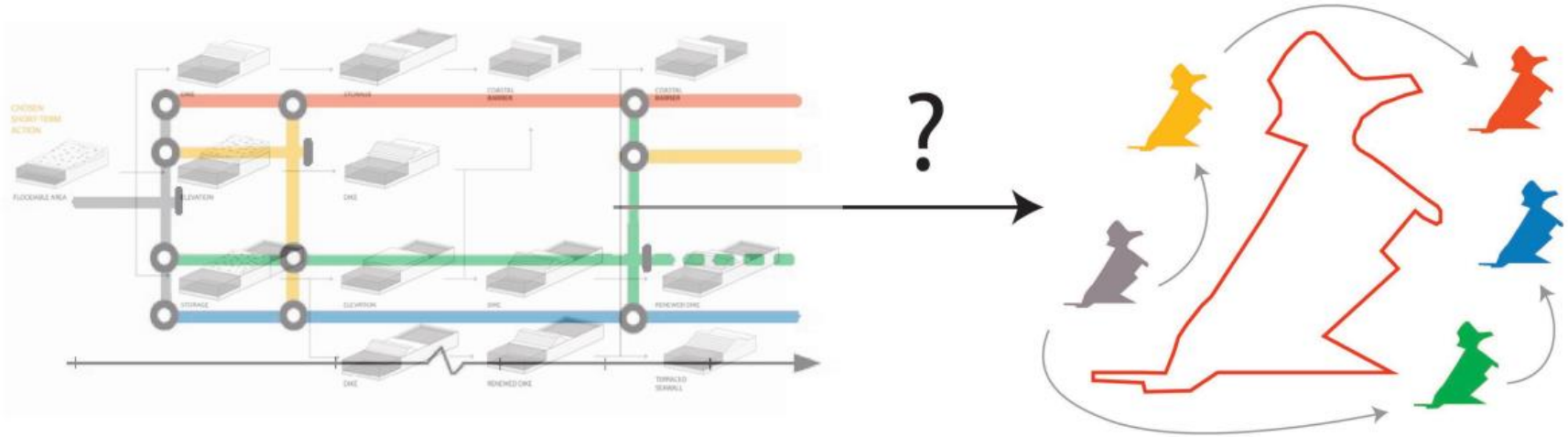


Adaptive policy pathways framework



From policy abstractions

to a spatial translation



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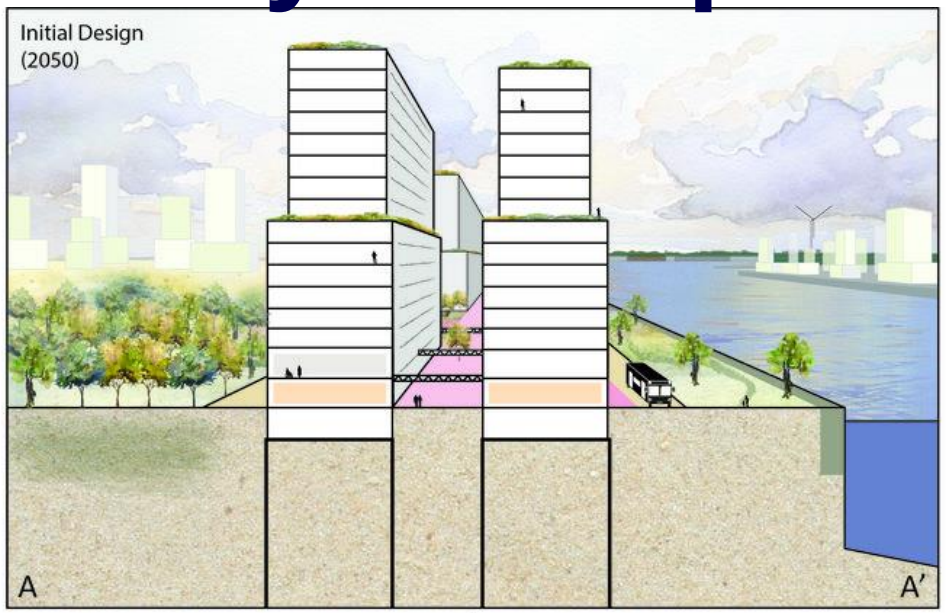
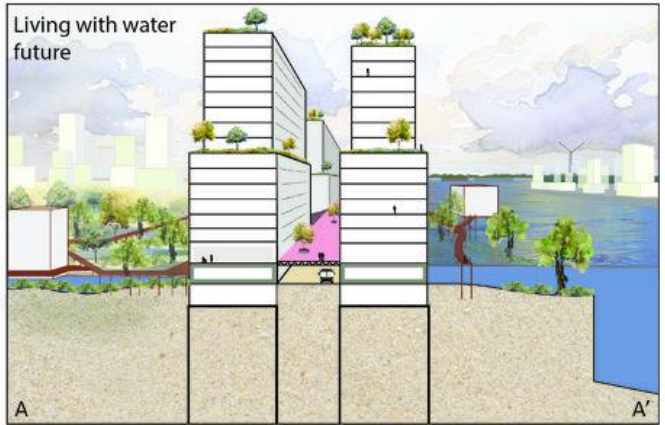
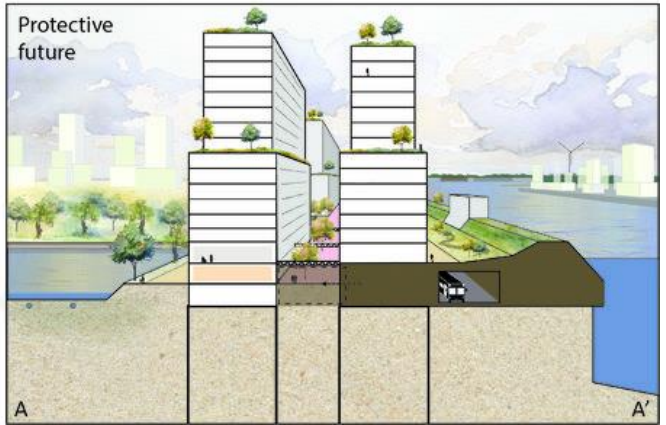
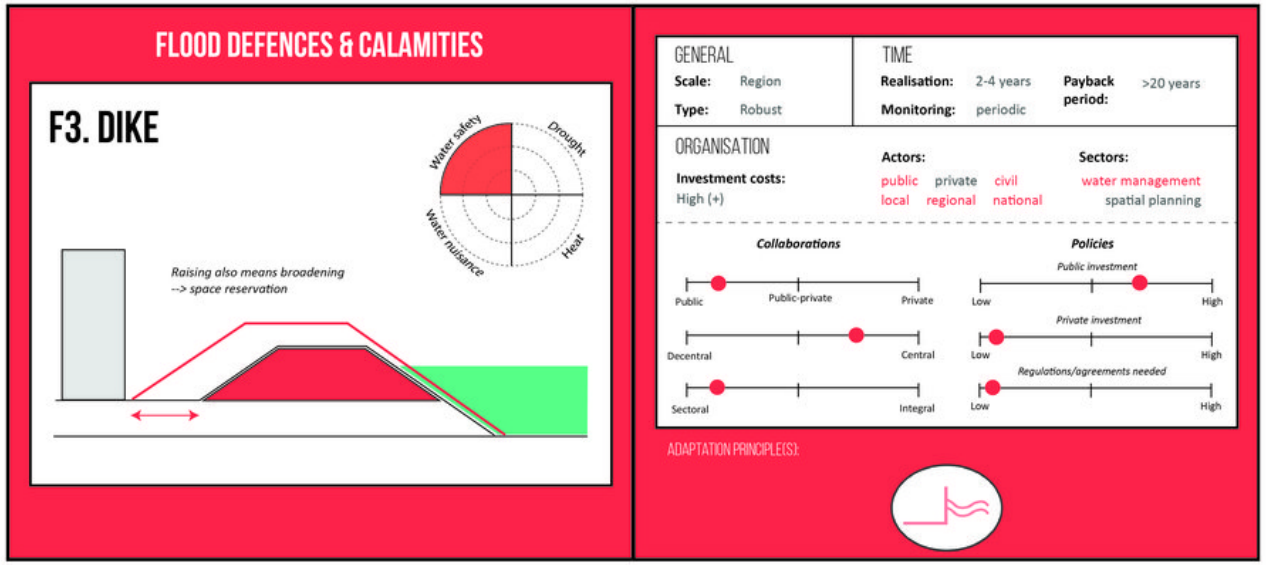
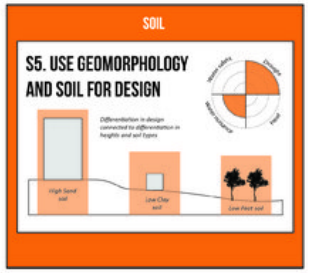
Spatial Adaptive Pathway Principles

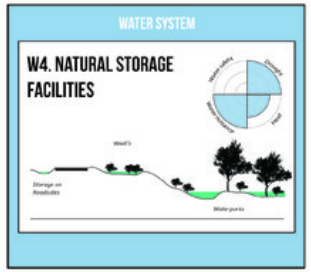


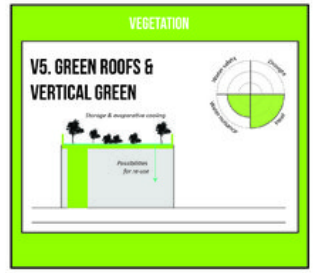


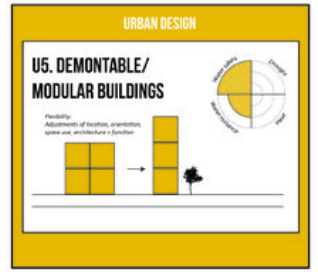


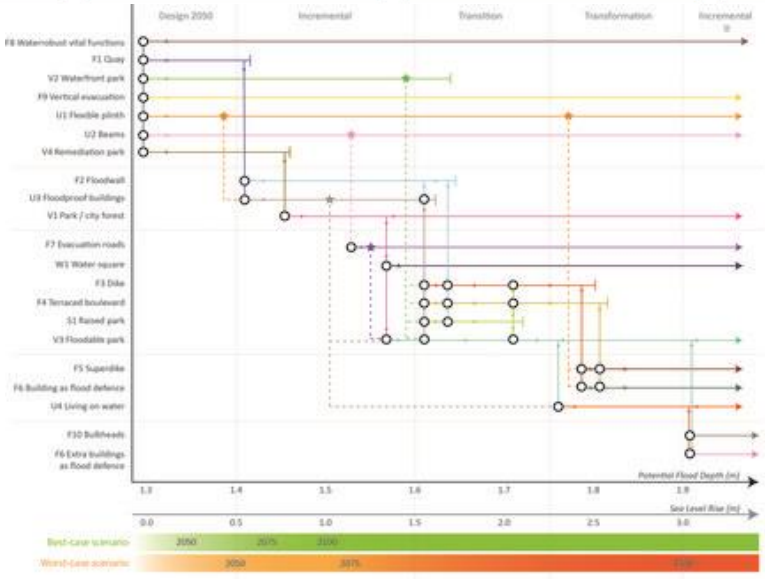








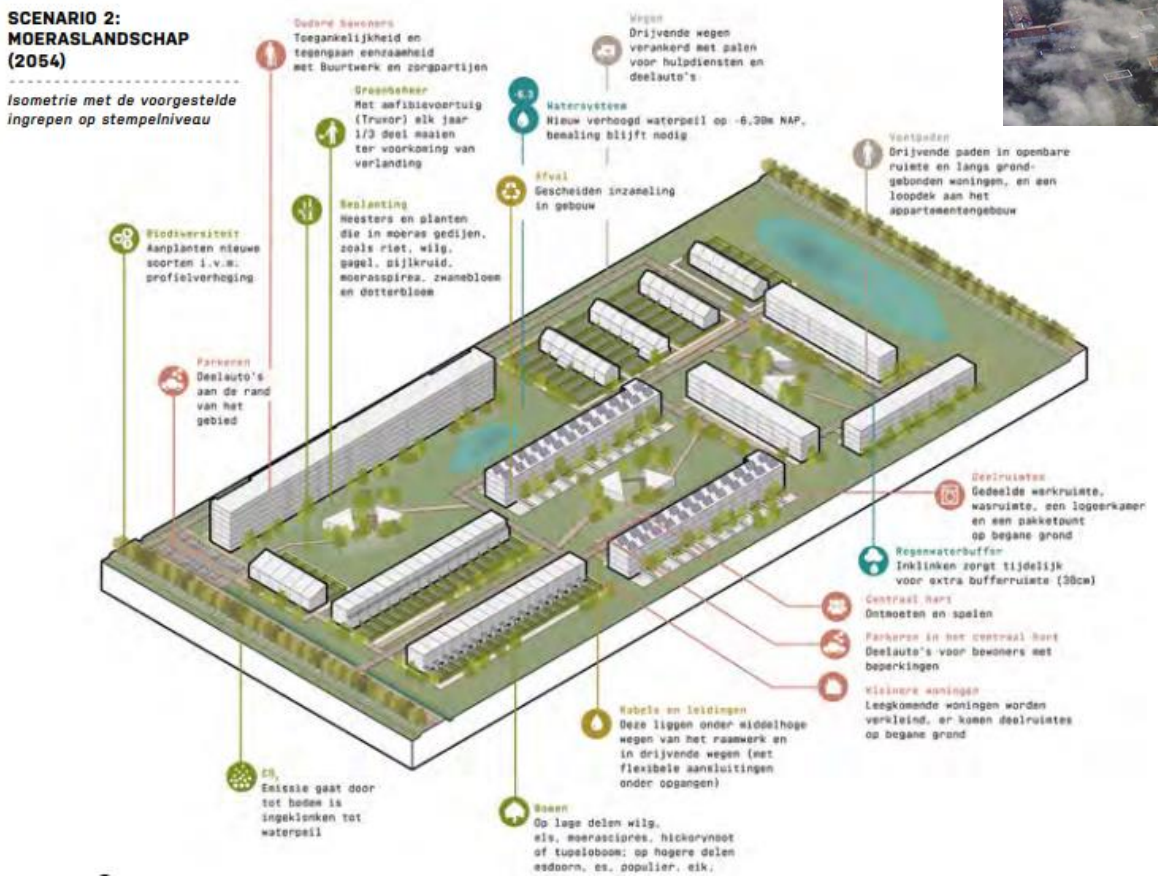




Water machine

Stad x Klimaat – BNA

5 teams



AMBITIENIVEAU L

- *Grote investering*
- *Geen terugkomgarantie bewoners*
- *Sloop en nieuwbouw*

Bijna al het regenwater wordt, al dan niet gerecycled, ingezet voor extra woonkwaliteit.

1. Regenwater wordt van de daken naar bassin A geleid.

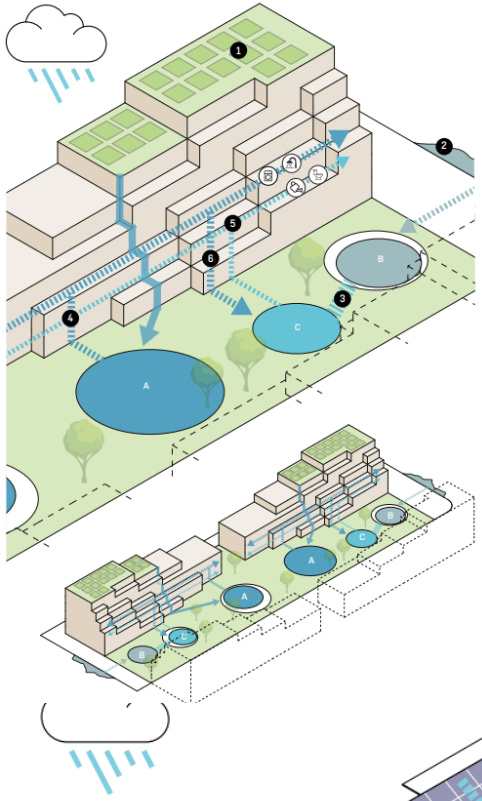
2. Water wordt van verhard maaiveld via straatkolken naar bassin B gebracht.

3. Water van 'vuil' bassin wordt met hydraulooptechniek grijs gemaakt (bassin C).

4. Water uit bassin A wordt gebruikt om te douchen en te wassen.

5. Water uit bassin C wordt gebruikt voor toiletten en groen.

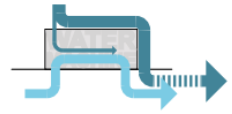
6. Gebruik douchewater wordt gereinigd en komt terecht in bassin C.



AMBITIENIVEAU M

- *Aanzienlijke investering*
- *Bewoners tijdelijk uithuizig*
- *Grondige renovatie*

Een aanzienlijke stroom regenwater wordt in en om het huis benut.



1. Een schuin dak met pv-cellen brengt het water naar een groenblauw dak.

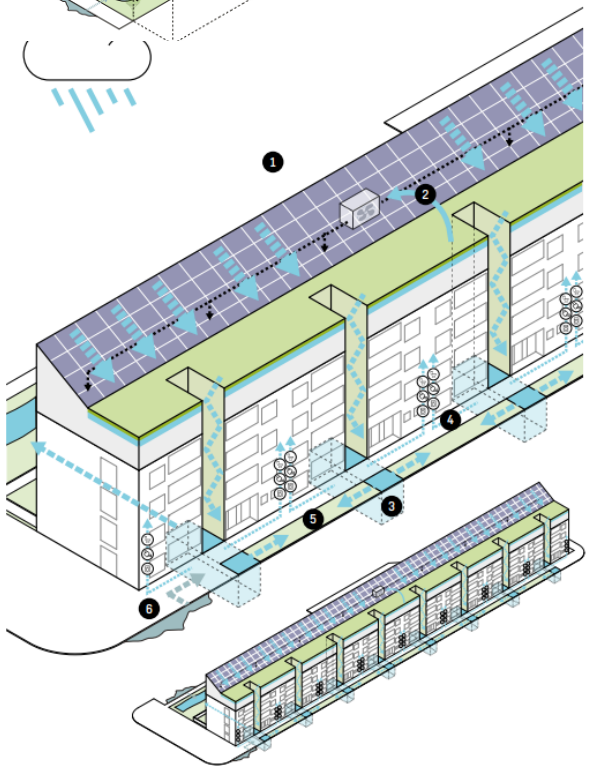
2. De lucht wordt gekoeld met verneveld regenwater.

3. Water(ver)val door verticale tuin, opslag in ondergrondse tanks.

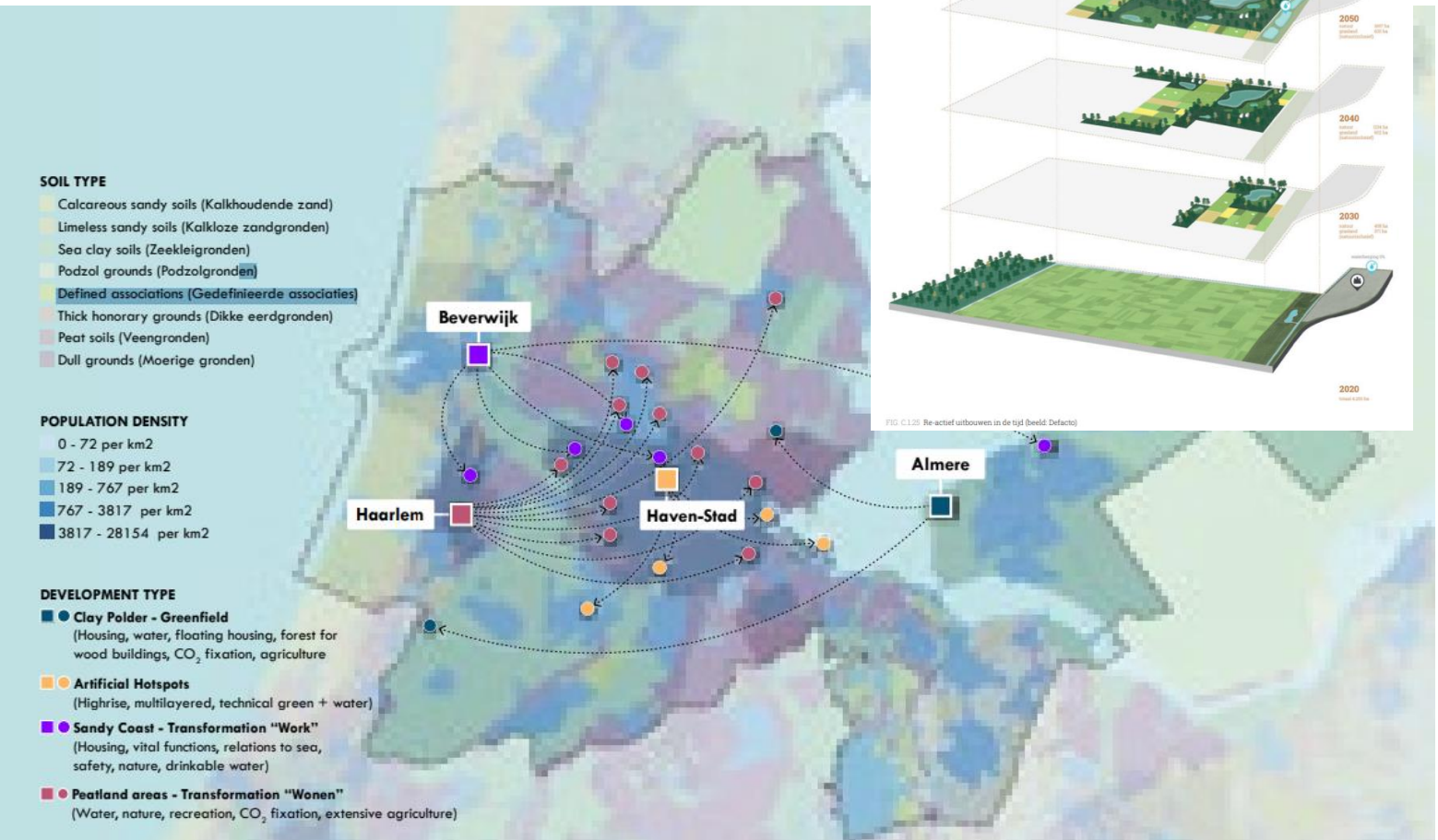
4. Grijswater uit tanks wordt gebruikt voor toiletten en groen.

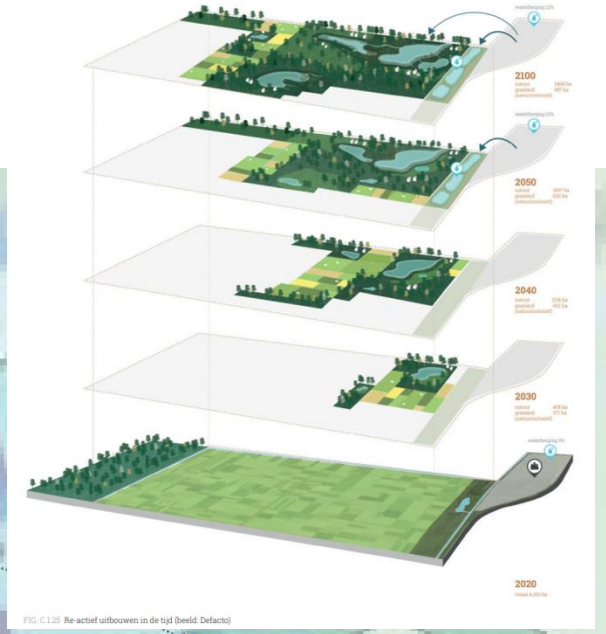
5. Bij een volle tank loopt het water over naar de regentuin of wadi.

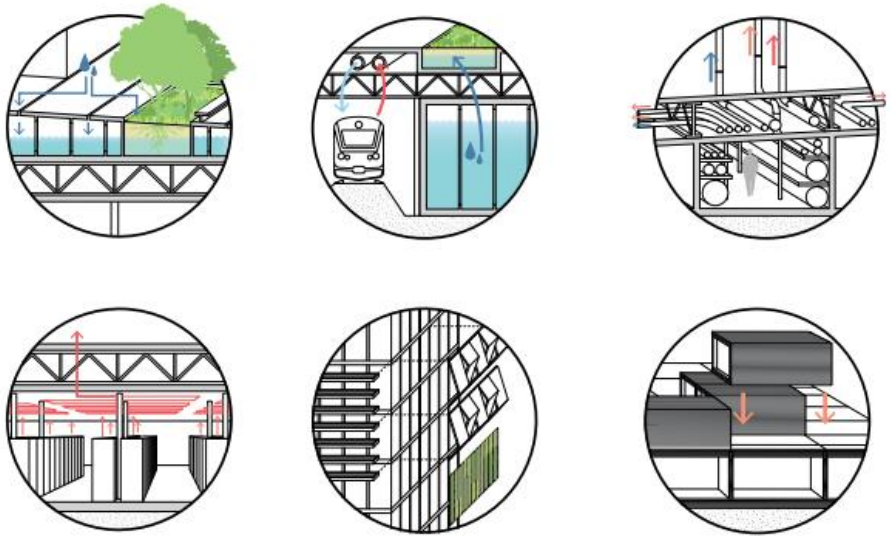
6. De wadi en regentuin kunnen ook water van straat opnemen.



MRA - Resilience by Design







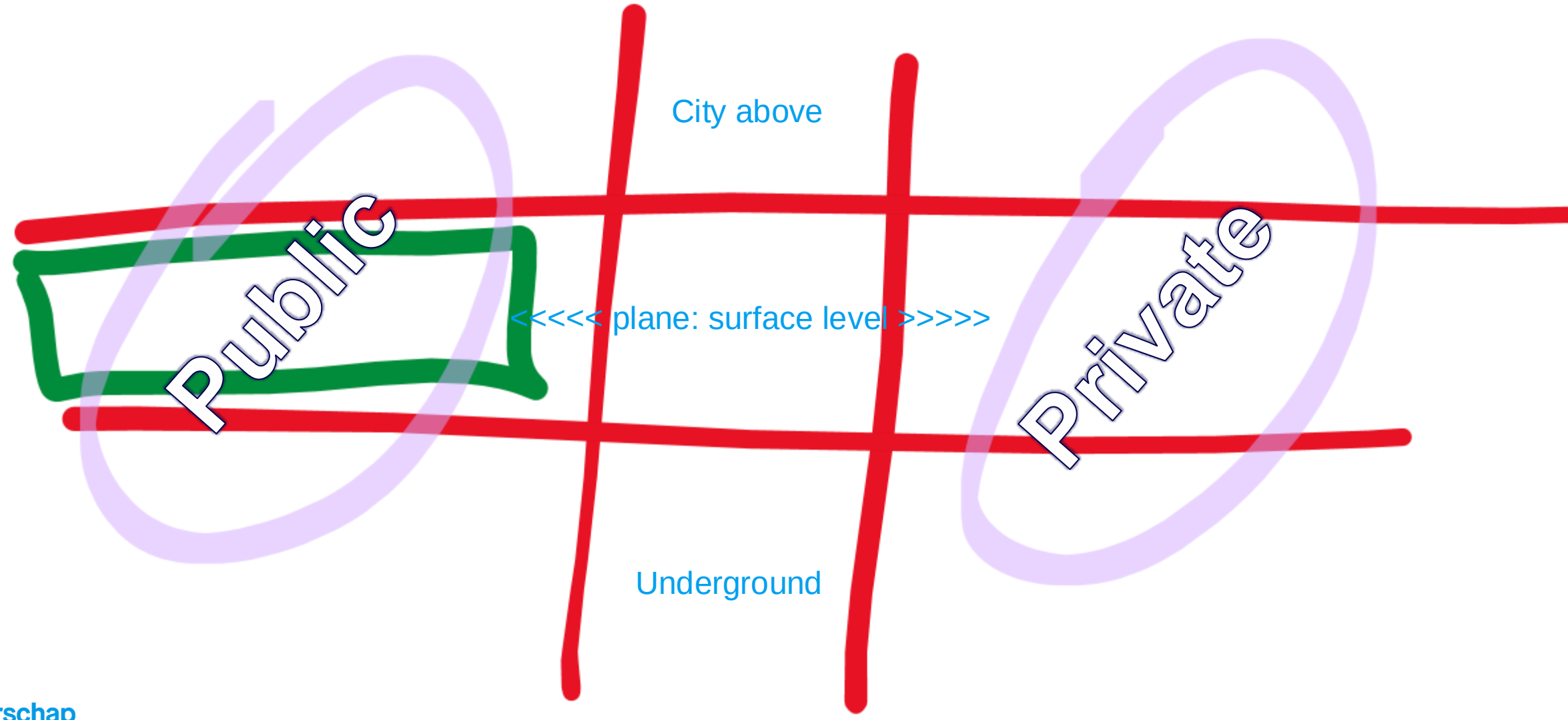
Elevation strategy Amsterdam

Z-focus in the urban landscape

Kasper Spaan

waterschap
amstel gooi en vecht

Development Elevation strategy Fase 1



waterschap
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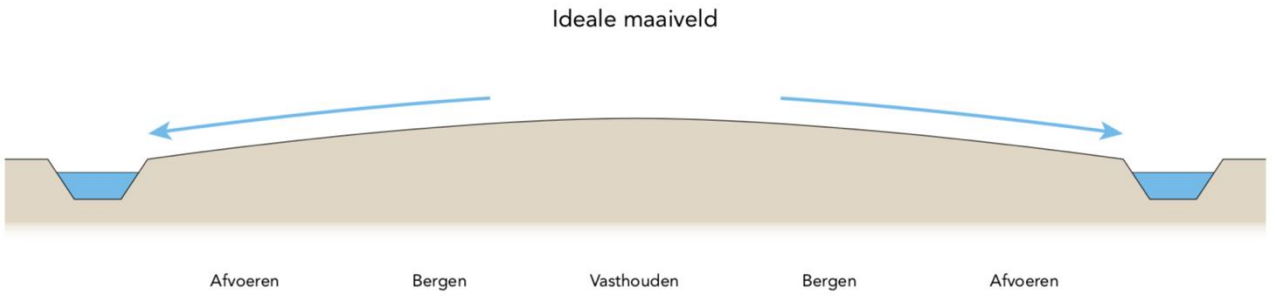
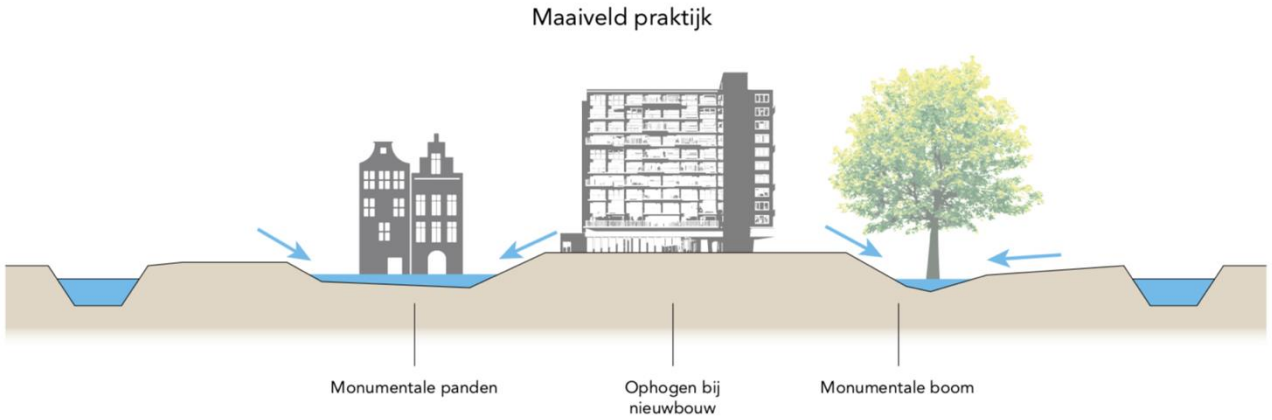
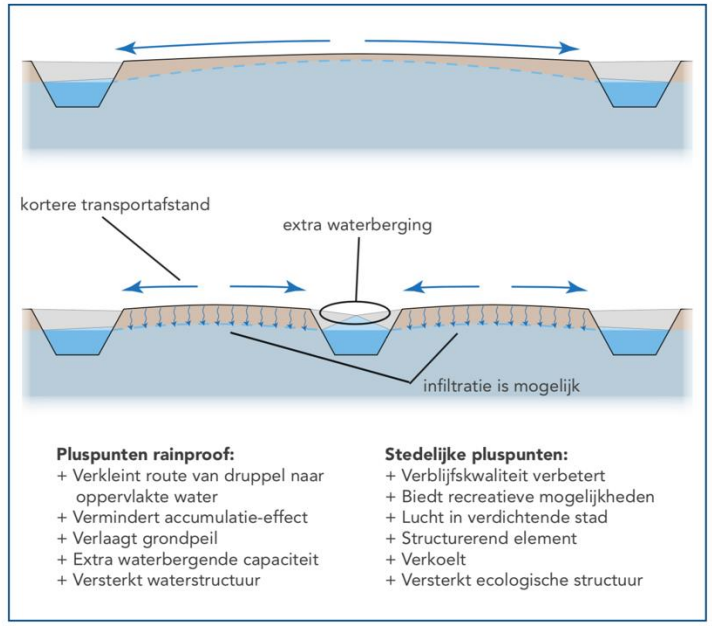
Fixing and guiding elements

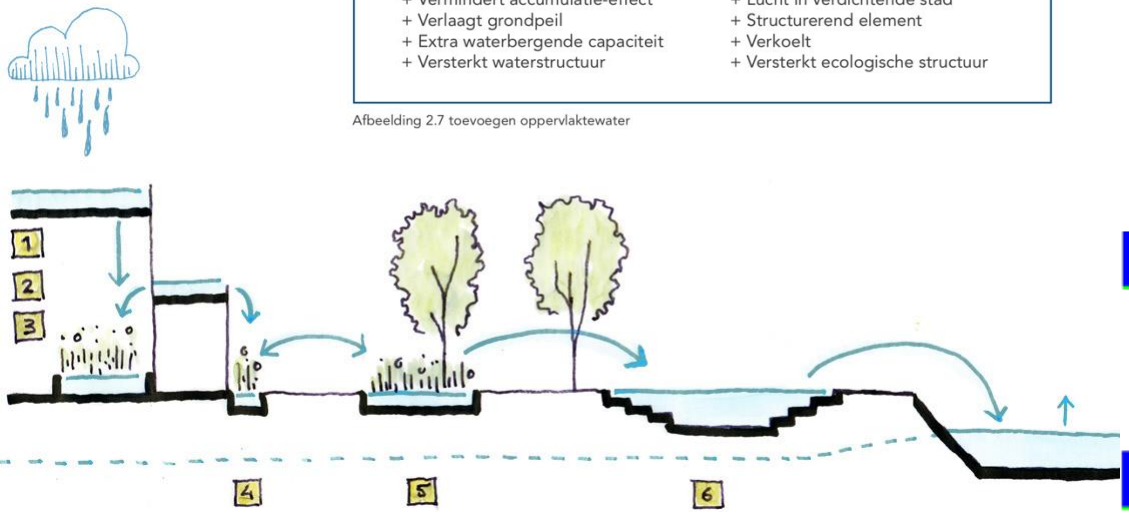


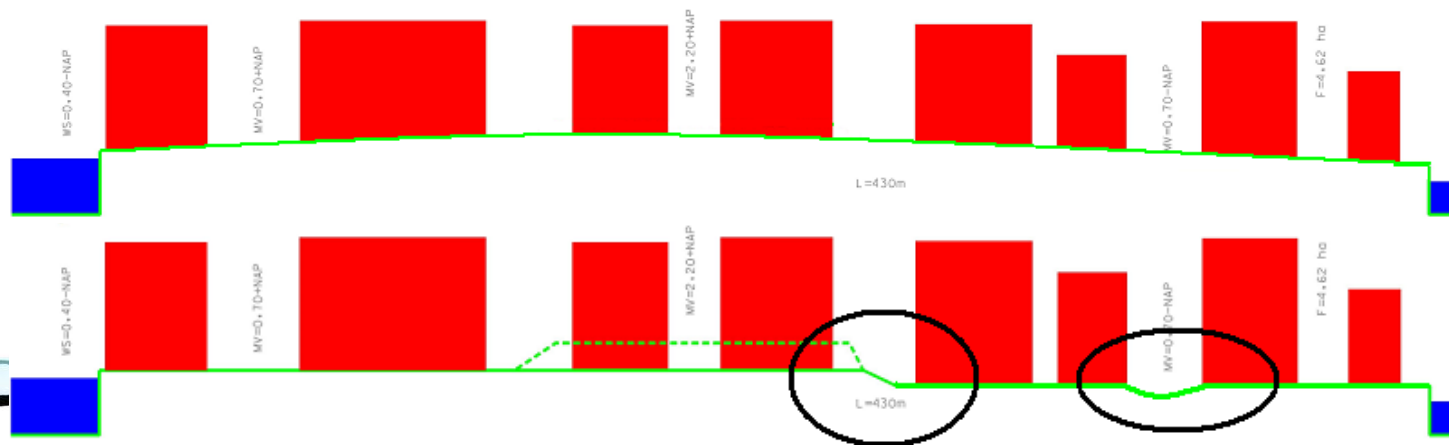


Afbeelding 2.6 Ideale maaiveld versus praktijk



Afbeelding 2.7 toevoegen oppervlaktewater





What is an Elevation strategy?

An approach that creates coherence in height measurements in policy frameworks, spatial planning products and development processes with impact on different scale levels in space and time. With the aim of implementing plans and decision-making that leads to a climate-adaptive city.

waterschap
amstel gooi en vecht

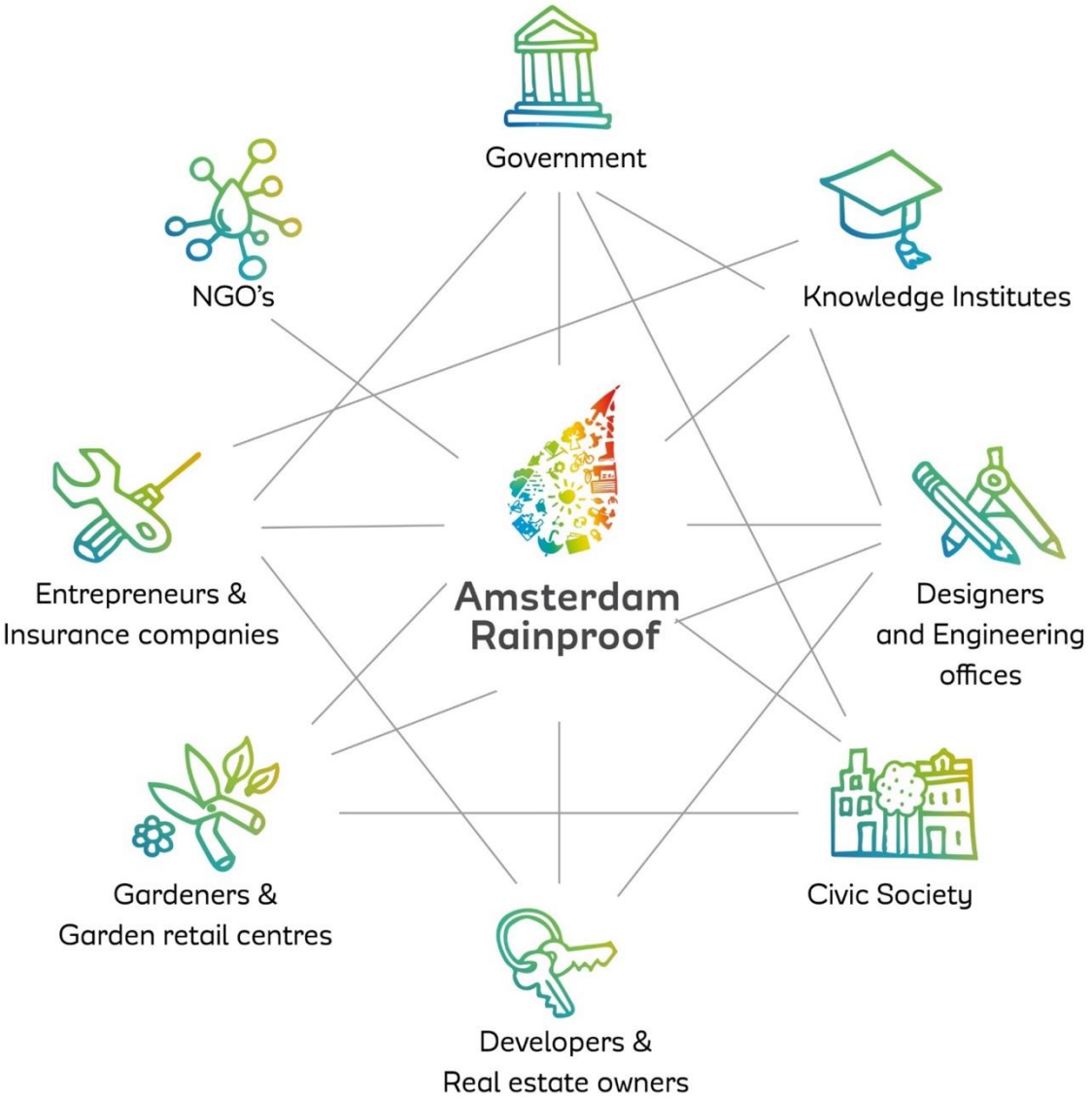
RAINPROOF
WEERPROOF

COMMUNITY MANAGEMENT IS KEY

KASPER SPAAN

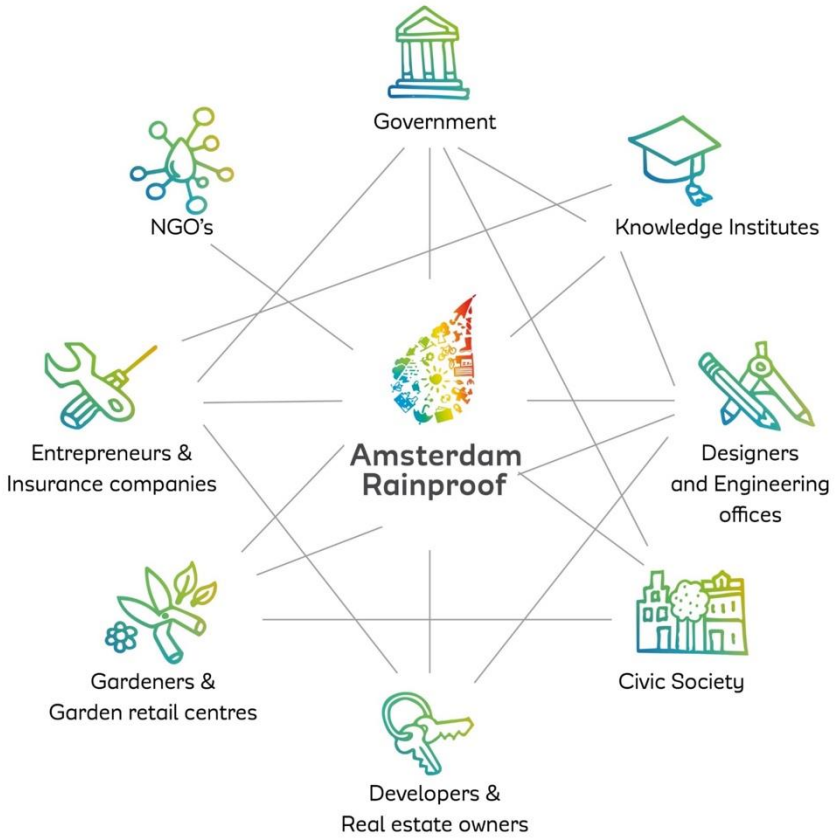
NETWORK BASED APPROACH

- Since 2014 – 2 years and extended
- Main focus: climate adaptive city 2050
  - Creating awareness
  - Connecting partners through community management
  - Autonomous entity
  - Mainstreaming private and public domain
  - Sponge City concept
  - Visible projects
- Program Climate Adaptation Amsterdam (since 2019)



Amsterdam Rainproof

elke druppel telt



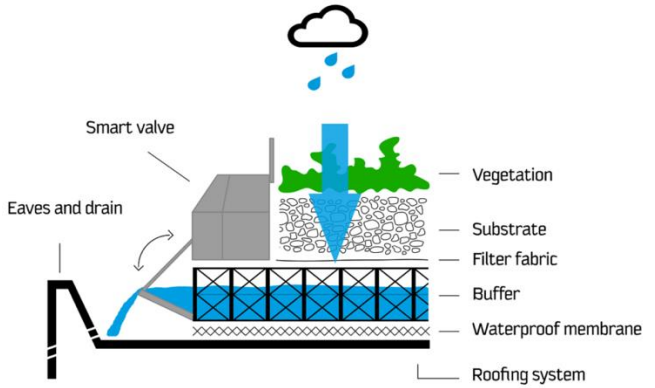
Amsterdam WEERPROOF

Blue-green roofs

waterschap
amstel gooi en vecht

Polderroof (2013) @ Old School

- Question: ***"When is a green roof blue?"***
- Realisation summer 2013 with GBC Zuidas, De Dakdokters, Waternet, Municipality of Amsterdam
- Waterpermit Regional Waterauthority for quantified waterstorage
- From green to blue: Substantial water storage on flat roofs (60 - 100 mm)
- Creating value through water on the roof
- Innovation: Valves for water level control
- Magnet for other functions: bee hives, solar panels, office cubes,



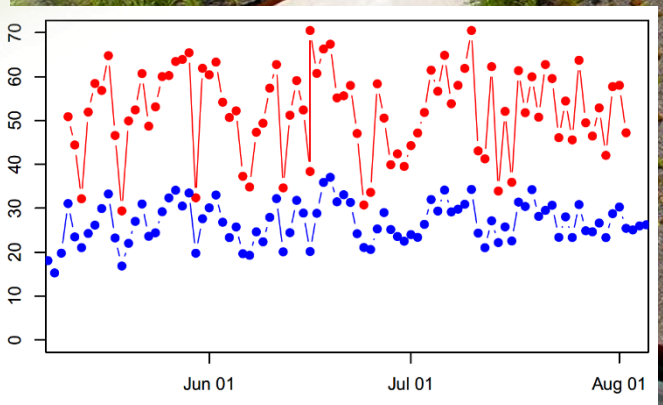
waternet
regional public water authority
amstel gooi en vecht
city of amsterdam

Amsterdam Rainproof

Polder Roof Old School Spin-off

- Water neutral building envelope
- Smart & dynamic micro water management through decision support system (DSS) – Public role on private property
- Scoping on governance challenges
- Collaboration with Green Business Club Zuidas: 25.000 m2 Blue green roof landscape and with NGO's: Groene Grachten, De Gezonde Stad, Amsterdam Rooftop Solutions -> Rooftop Revolution
- Project Smart Roof (2017-2019): Scientific research on quantified cooling power and water availability on the blue-green roof
- Policy instrument: **Rainwater ordenance**
- Growing awareness on the blue power on roofs in the combination red – yellow – green: National Roof Plan
- Smart blue-green roofs are suitable to reduce heat and balance droughts and extreme precipitation
- Water availability is the key to a biodiverse living green (roof) landscape
- Framework Multifunctional roofspace + ***RESILIO***

Ecosystem approach
Mission driven



NATIONAAL DAKENPLAN

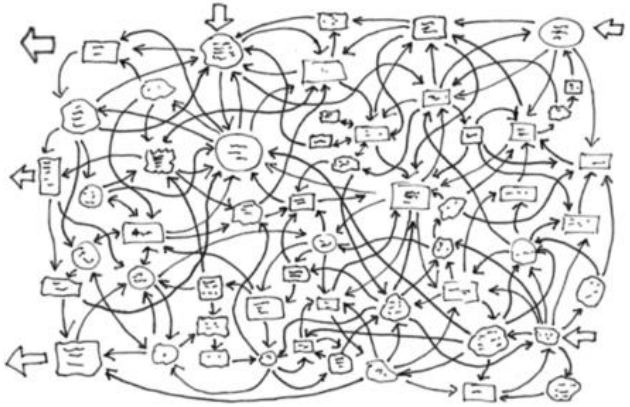
CONCEPT OF ADAPTIVITY

CASE ADAPTIVE ARCHITECTURE

- Complexity and uncertainty dominant in current society
- Integral challenges & stalled processes
- Building for the unknown future…

New instruments in development:

- Decision Making Under Deep Uncertainty
- Adaptive Pathways – policy development



Adaptivity is key

ADAPTIVITY IS ...

Moldable
Timeless
Broad Horizon
Resilience
Limitless
Multi-dimensional
Fitness

IS NOT:
Raising the Bar
Finding a new standard
Stronger and bigger

Amsterdam
WEERPROOF

MULTISECTORAL ADAPTIVENESS

Adaptive DESIGN
Adaptive FINANCE
Adaptive PATHWAYS
Adaptive ARCHITECTURE
Adaptive DEVELOPMENT
Adaptive INFRASTRUCTURE
Adaptive GOVERNANCE

New culture on development / design / urbanization in coherence with future water management

- From feasible to adaptable
- No turnkey delivery real estate but with adaptability manual
- Short response time: modularity, temporary
- Initially address smart, cheap and flexible choices in design
- Elevation strategy for coherence in Z: 2D > 3D > 4D …
- Can we pre-invest or do we bear the costs afterwards?

waterschap amstel gooi en vecht