Towards a Flood Resilient City

IWHR 2017

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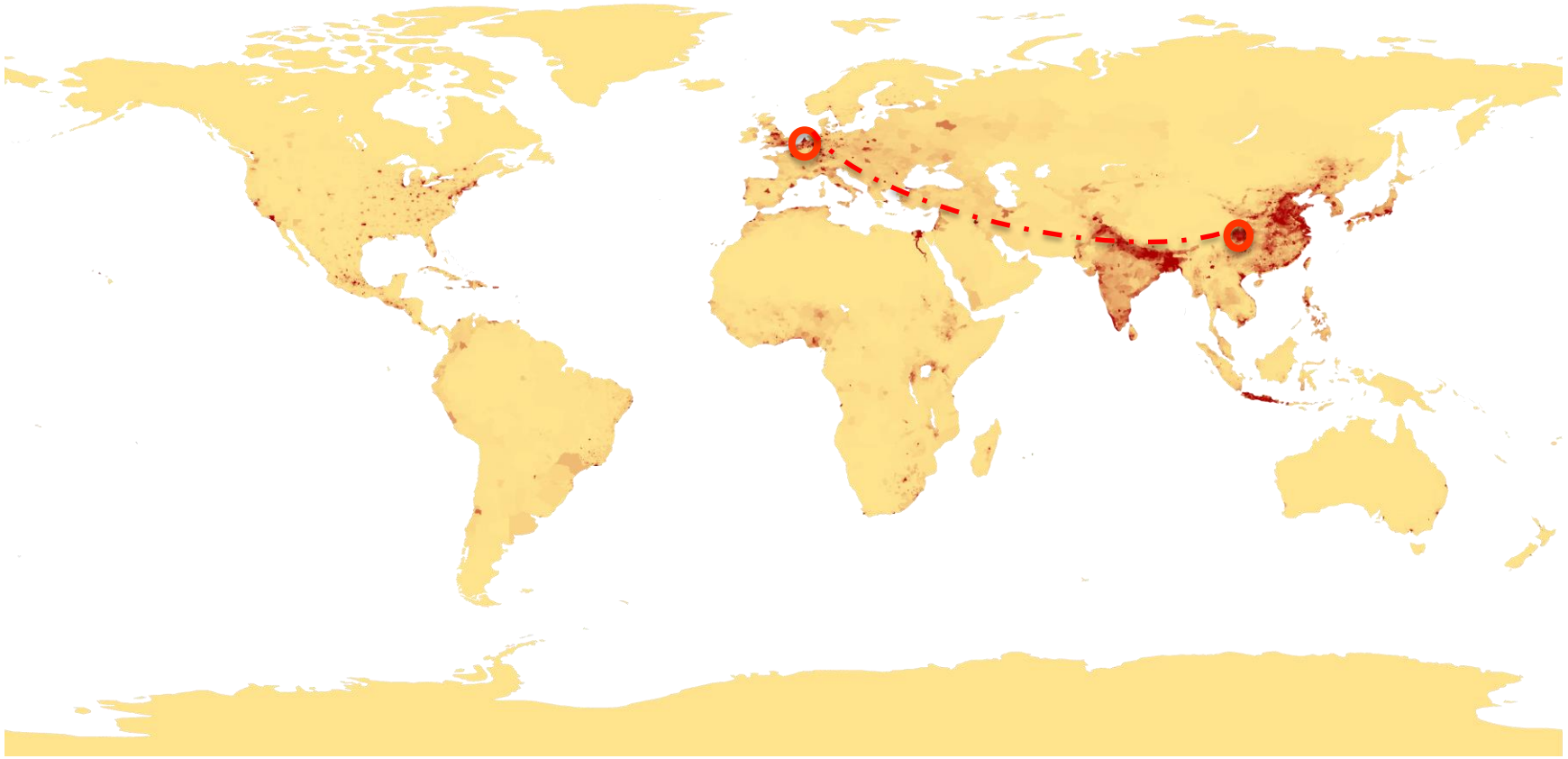
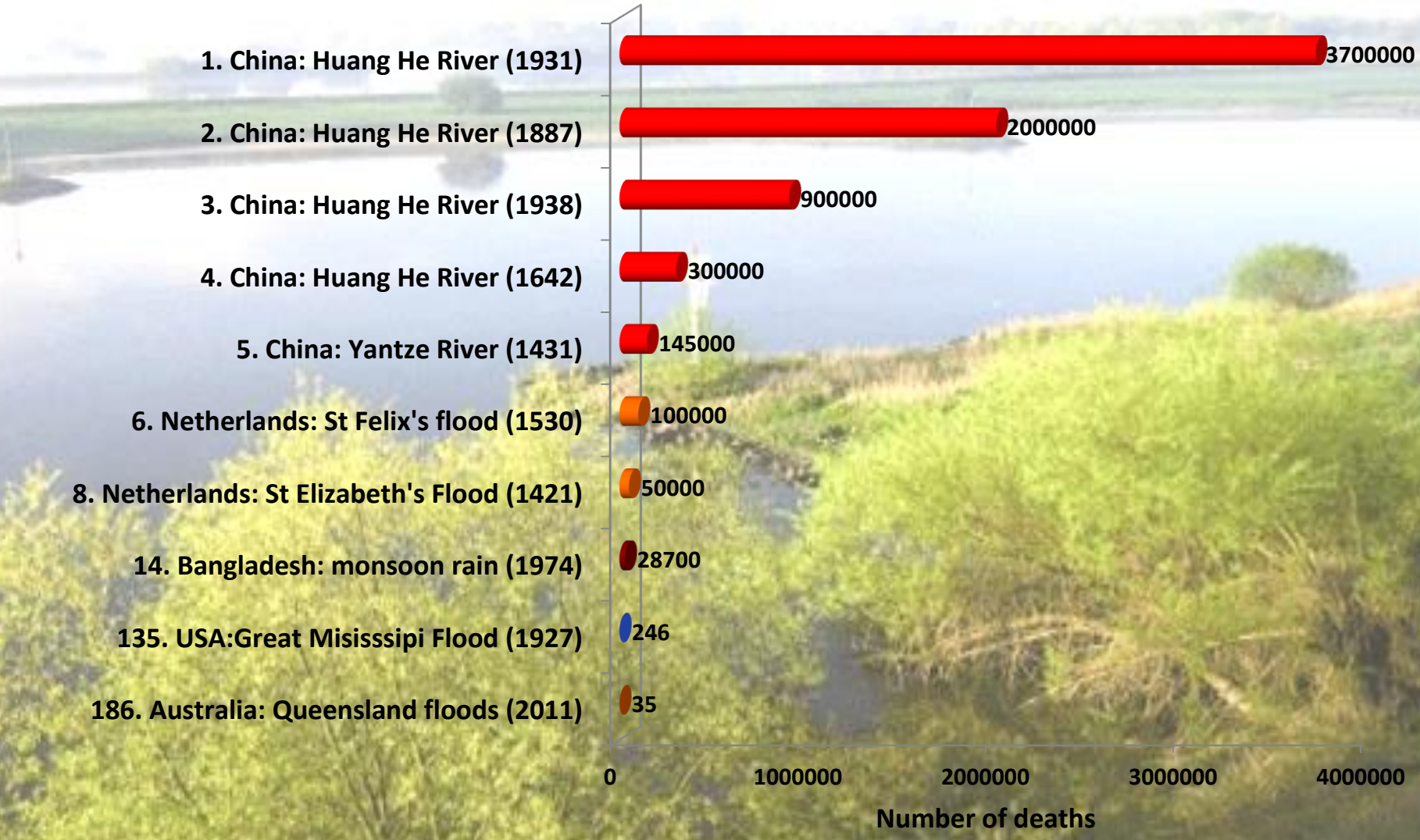
China & The Netherlands




The Netherlands
(End of the Silk Road)

The World's Worst Floods by Death Toll



UNESCO-IHE Institute for Water Education

www.unesco-ihe.org

UNESCO IHE DELFT

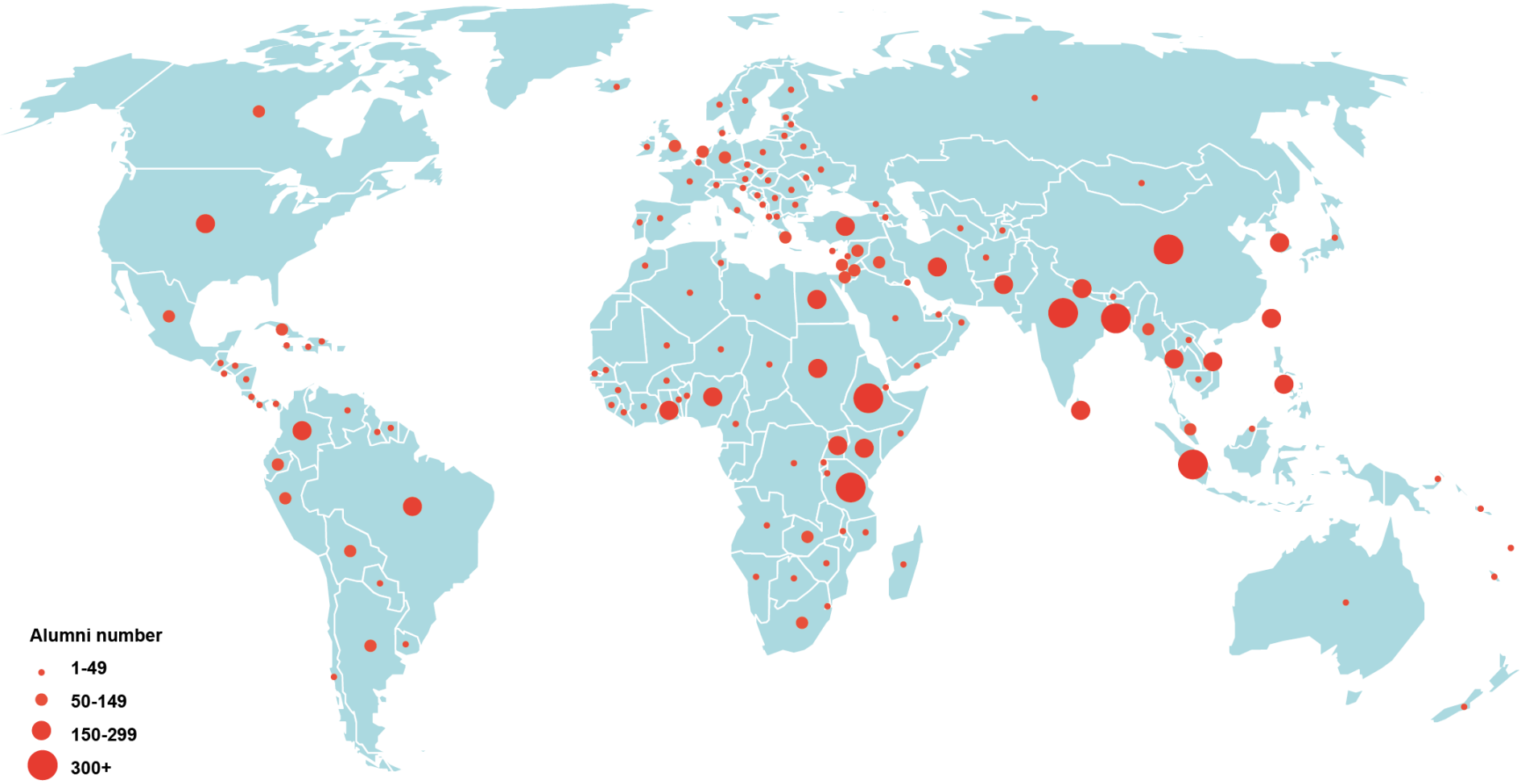


UNESCO-IHE is the largest international graduate education institute in the field of water. The institute confers fully accredited MSc degrees and promotes PhDs.

Since 1957 the Institute has provided graduate education to more than 15,000 water professionals from over 162 countries, the vast majority from the developing world.

140 PhD fellows are currently enrolled in water-related research. The Institute carries out numerous research and capacity development projects throughout the world.

Alumni network



UNESCO IHE DELFT

Flood disaster 1953

Delta Commission 1.0

- **Predict and control regime;**
- Neglect of man;
- Top down;
- Delta works;
- Stringent safety standards based on fixed drivers.


1995

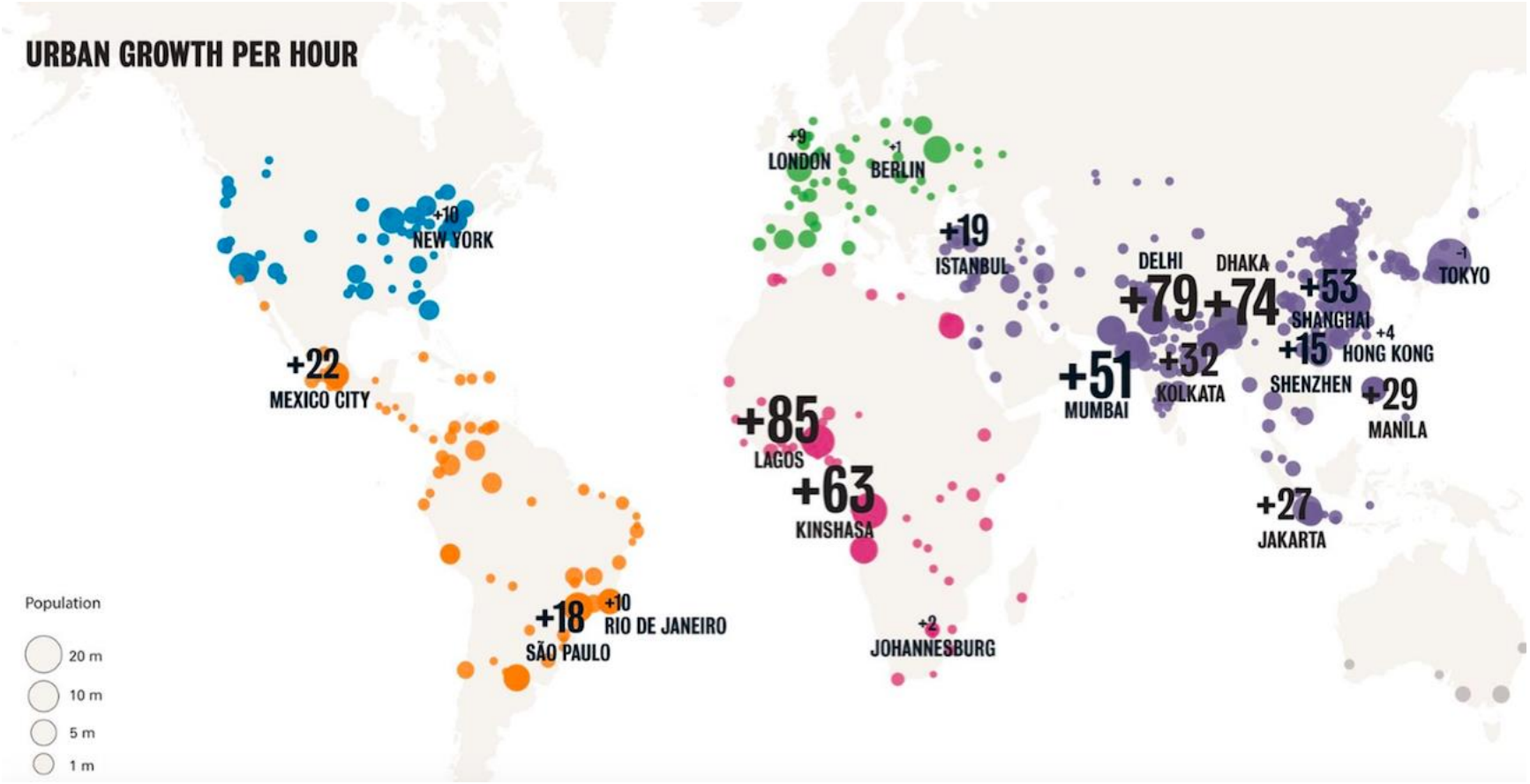
River flood: 1993 and 1995 (narrow escape)

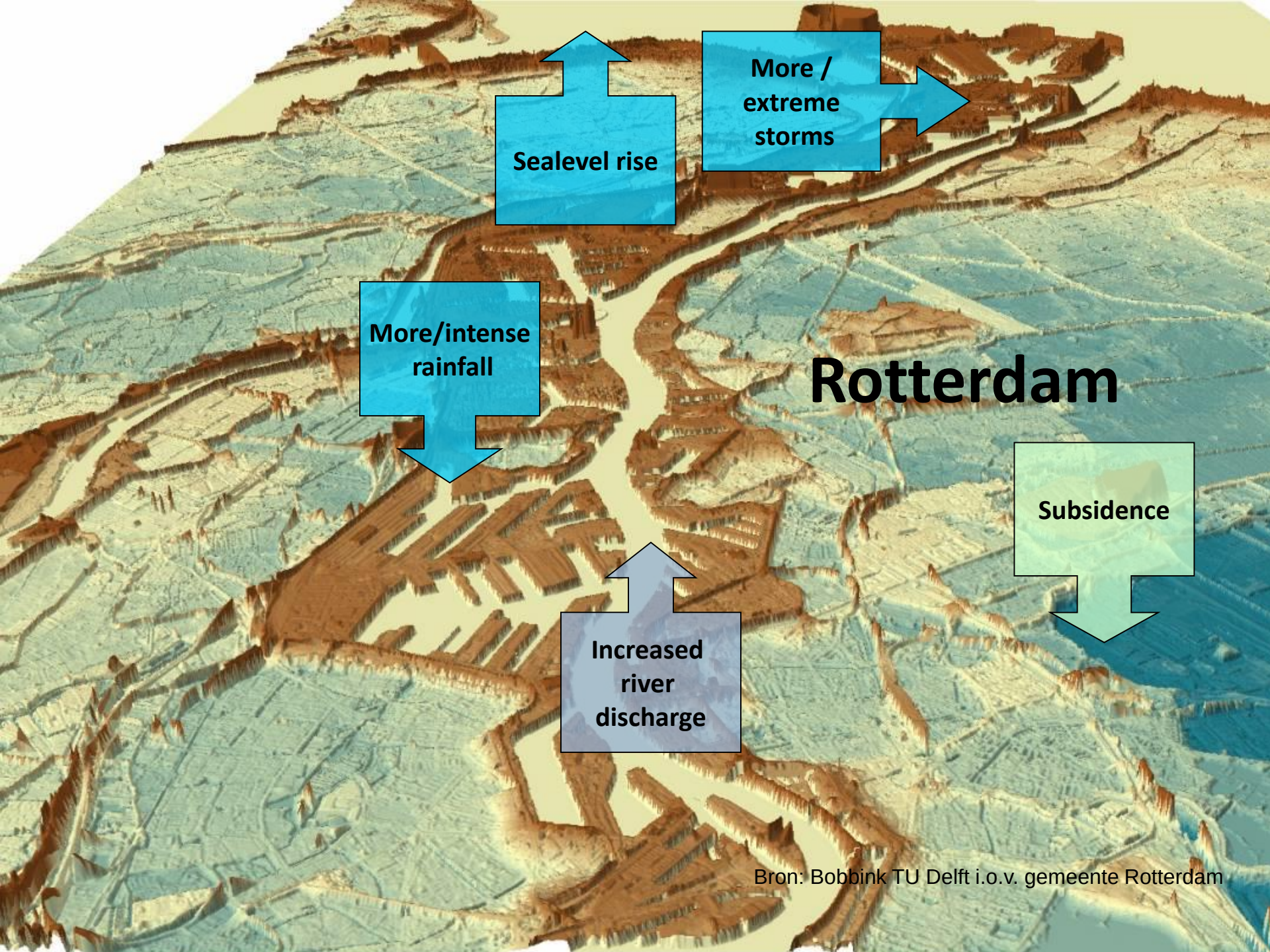
Delta Commission 2.0*

- **Integrated and adaptive regime;**
- Changing drivers and deep uncertainty;
- Multi-level governance:
- Effective public participation;
- Long-term perspective and short term benefits
- Protection, prevention & preparedness.

* 2014 - 2050

Cities in global context





Bron: Bobbink TU Delft i.o.v. gemeente Rotterdam


SANDUX ZONWE

China

Urban population increased a six fold in number since 1980 (for comparison, a similar relative increase took Europe more than 120 years)

An average annual growth rate of 12% over the past 15 years!

Urbanisation = asphalt and concrete based grey infrastructure (roads, buildings and parking lots)

Creates large amounts of stormwater runoff

What we share

- Lack of guidance, models, DSS and regulations
- Multiple benefits: how to value these benefits?
- How to operationalize resilience (balancing structural vs non-structural)?
- Demonstration sites/experiments: how to upscale?

Trends

- Complexity increases
- Smart, sustainable & resilience ?
- Changing role of local governments
- Changing attitude citizens/end beneficiaries
- Call for world-wide exchange of best practices

Any (flood) risk management system

Inherently imperfect:

- **Highly dynamic environment**
- **Large uncertainty in flood risk estimation**
- **Investments upfront, benefits remote (and uncertain)**

Cities most vulnerable places!

Key questions

- How to design ?
- How to value ?

How to design?

(modified from iBuild, 2016)

Dimension	Traditional approaches	Emergent approaches
Rationale(s)	Economic efficiency (and social equity)	Unlocking economic potential (e.g. GVA, employment)
Focus	Individual infrastructure items (e.g. roads, bridges, rail lines)	Infrastructure systems, interdependencies (e.g. connectivity, power, telecommunications, district heating, urban resilience)
Timescale	Short(er) 5-20 years	Long(er) > 30 years
Organisation	Projects	Packages of projects (programs)
Scale	Small, targeted	Large, encompassing
Planning process	Robust (risk-based) approach	Adaptive (resilient-based) approach
Lead	Public sector	Public and/or private sectors (including international)

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Risk-based approach

(to infrastructure design)

Risk = **Probability** x Consequences

- estimates based on historical data

Proposed solutions offer large, grey infrastructure:

- concrete levees, dams retention basins, culverts, drainage pipes

Low probability of failure ("**fail-safe**" infrastructure)

But what if they fail?


ELLAND B

Resilient-based approach

(to infrastructure design)

Embraces unforeseen extreme weather events

- designed for failure ("**safe-to-fail**" infrastructure, exceedance of design criteria)

Safe-to-Fail:

- Maintaining system-wide critical services (instead of preventing component failure)

- Minimizing consequences (instead of probability)

- Designing decentralized, autonomous infrastructure systems (instead of centralized, hierarchical systems)

Resilient-based approach

(to infrastructure design)

Sail-to-Fail infrastructure:

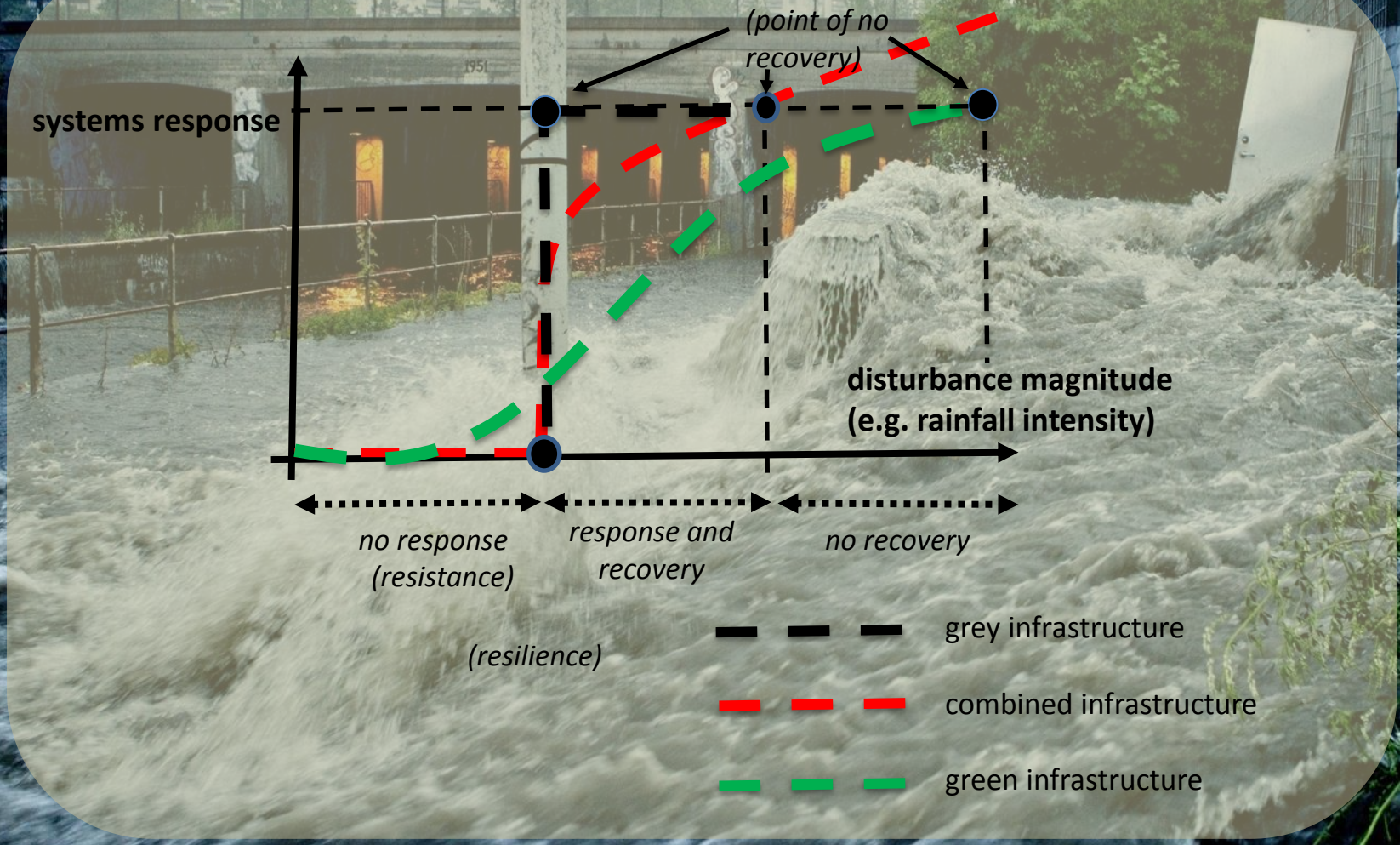
- Ability to respond to unexpected threats by rebuilding/adapt infrastructure (adaptive capacity (sense and adapt))
- Ability to recover (recoverability)

via *social, ecological and technological* interactions (SETs)


Elbe, 2013


Dordrecht, 2013

Systems behaviour



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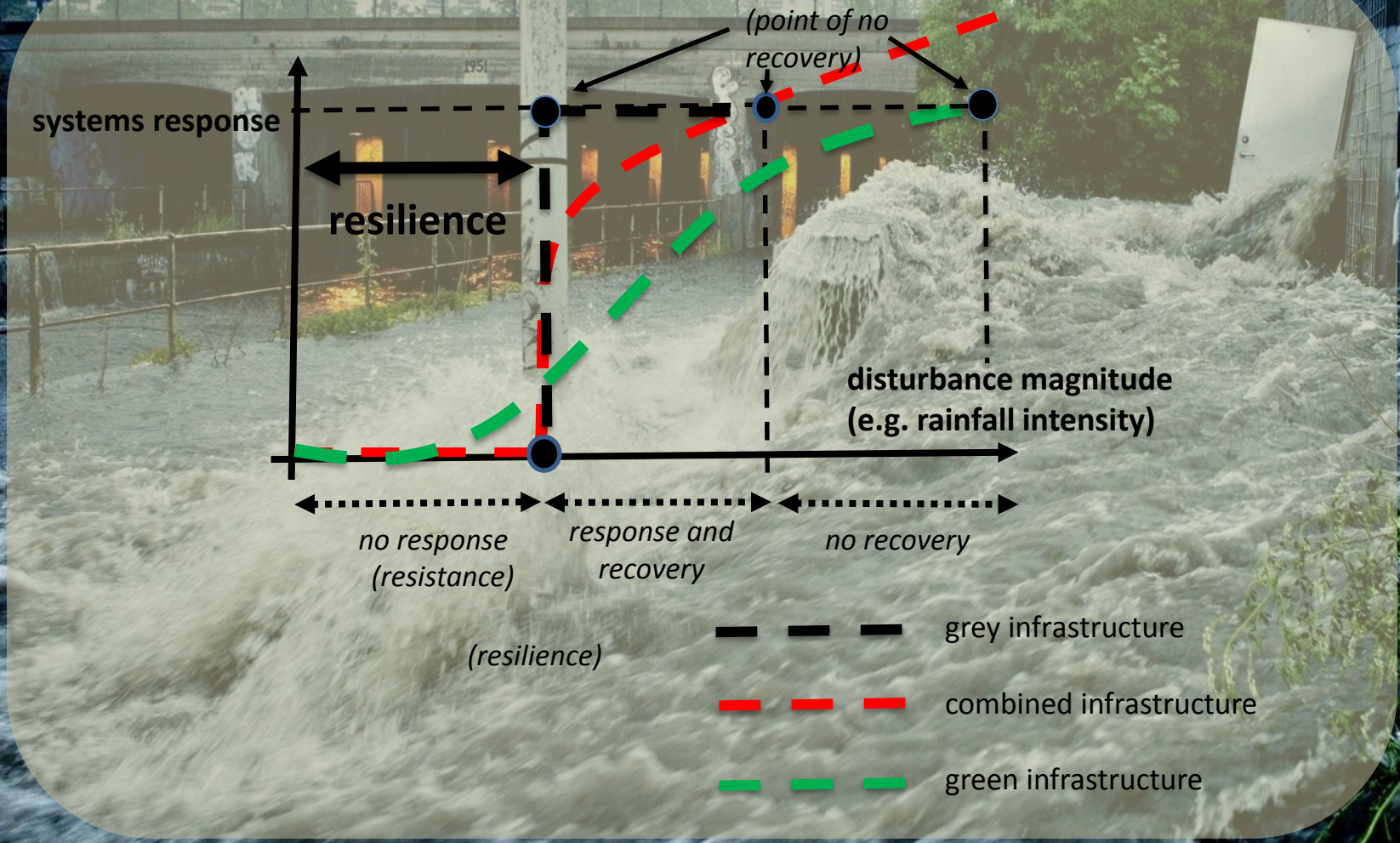

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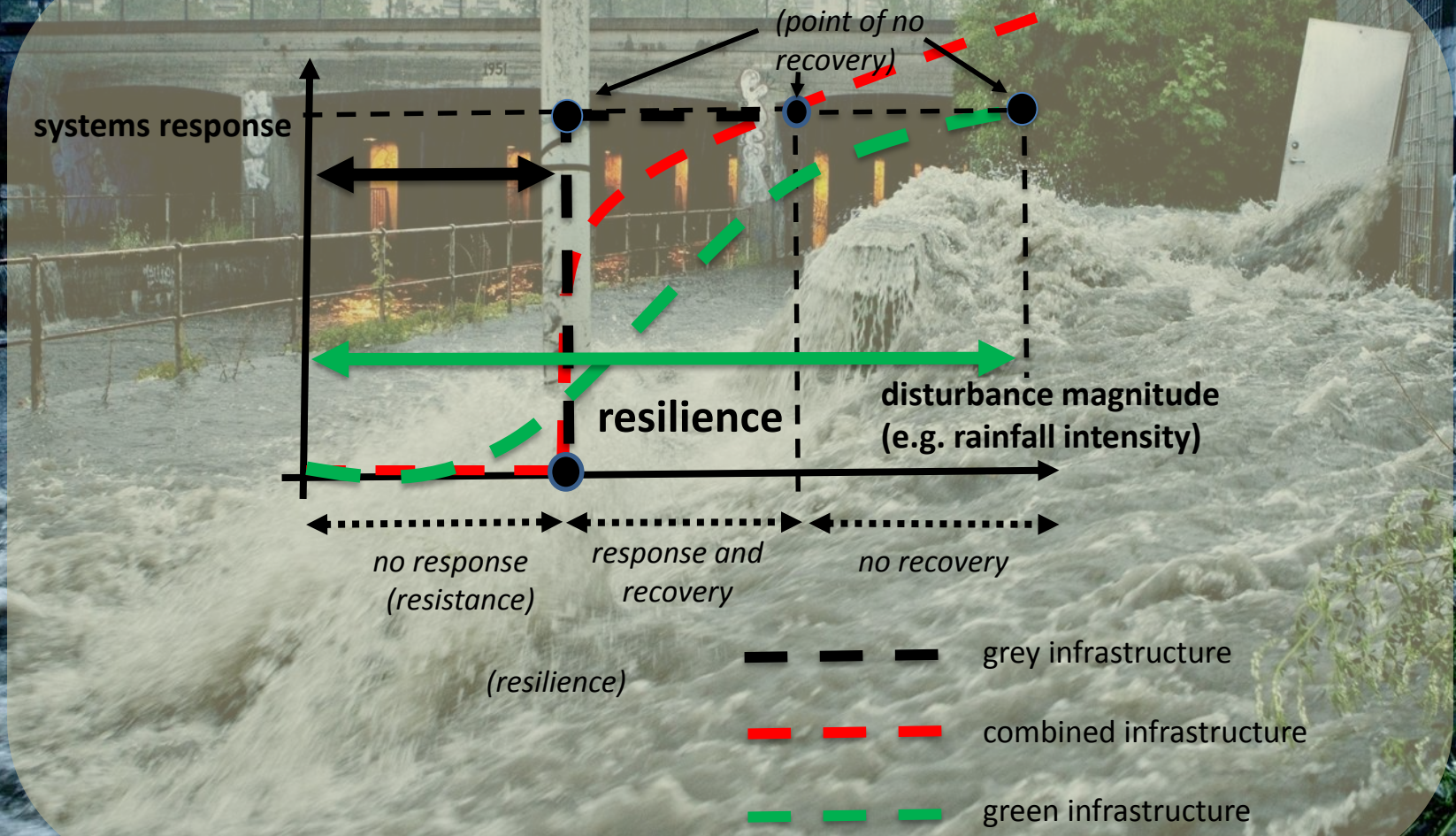
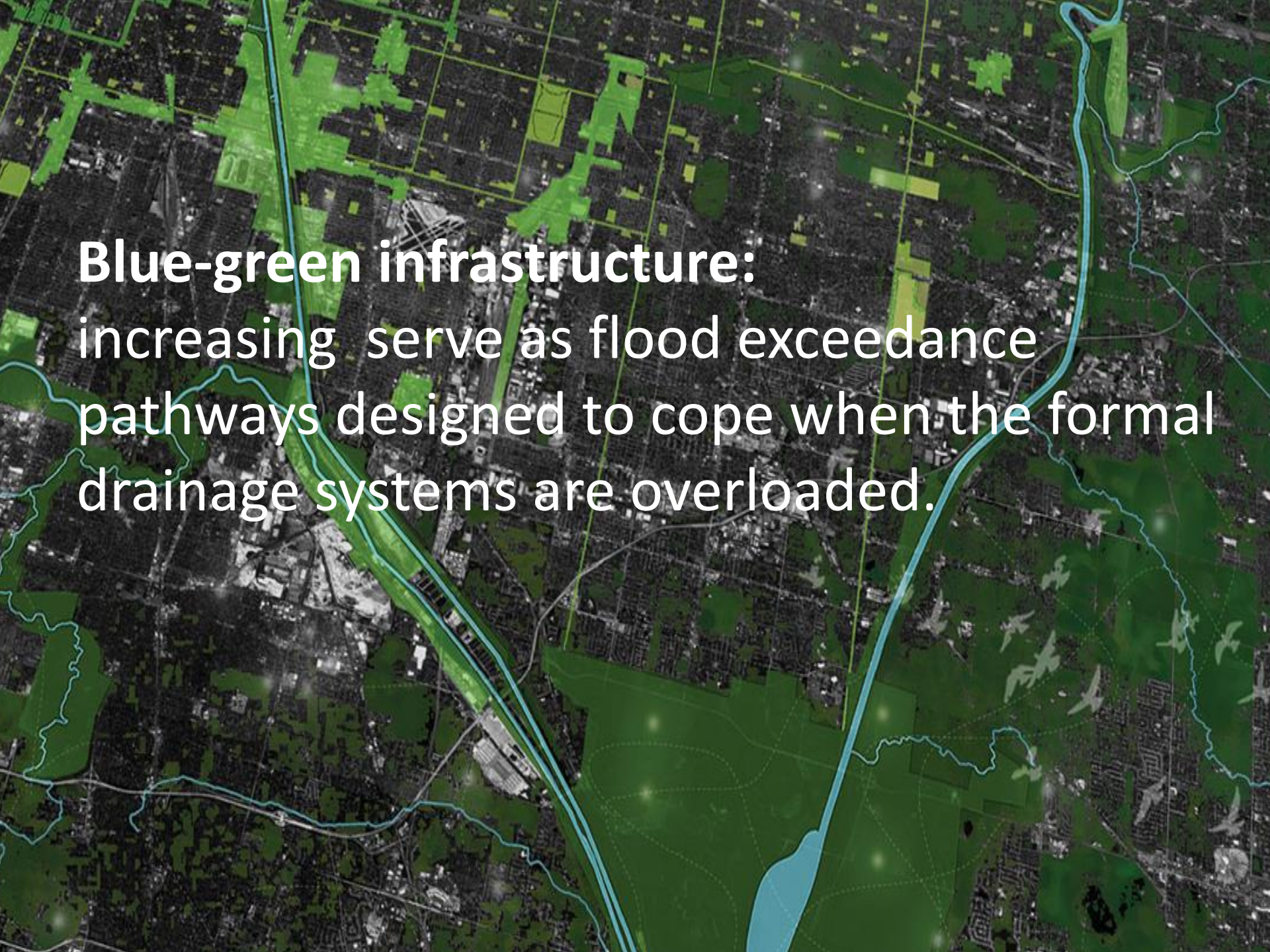




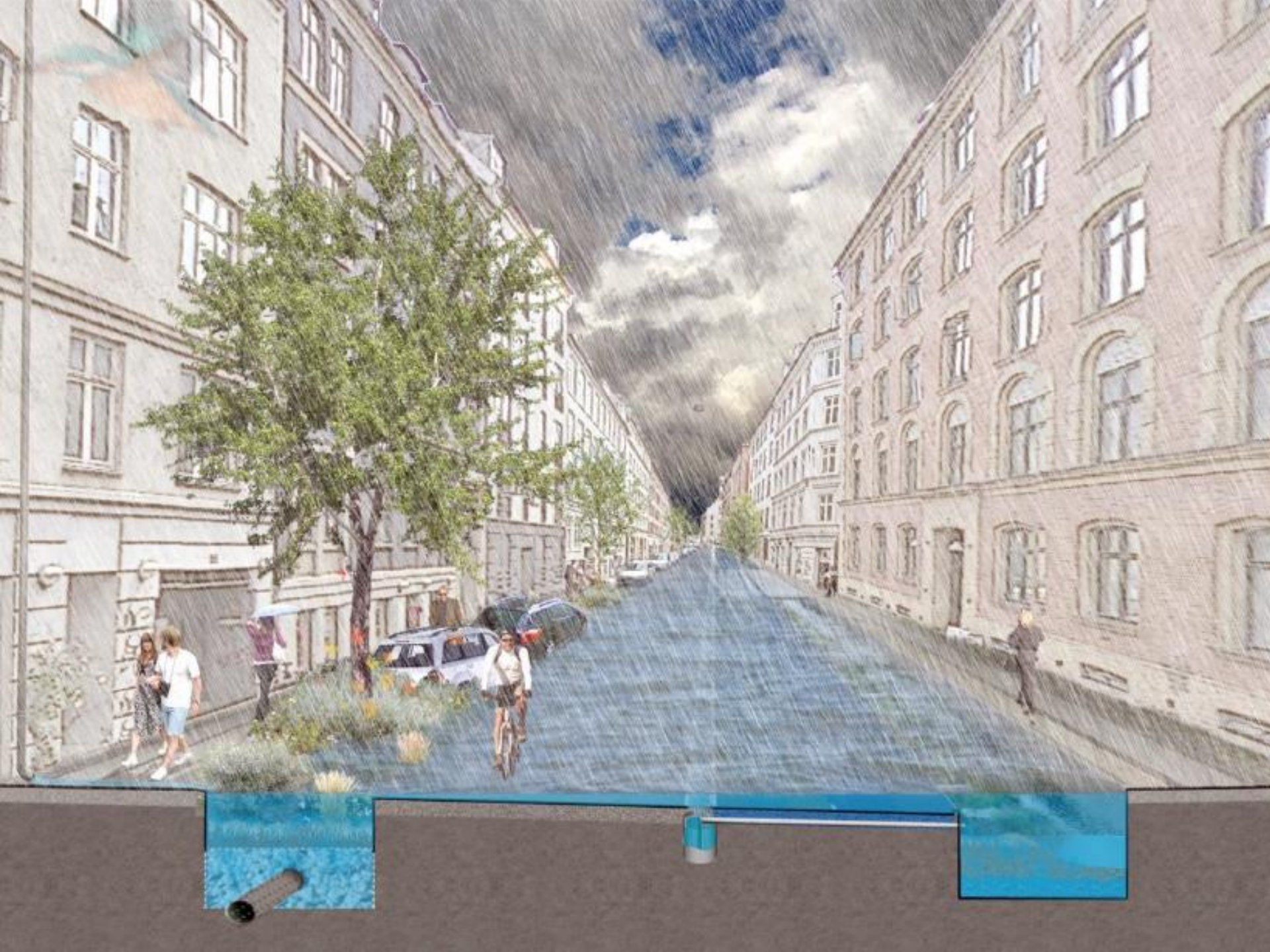
Blue-green infrastructure:
increasing serve as flood exceedance pathways designed to cope when the formal drainage systems are overloaded.


Reconnecting the floodplain in rural catchments

SUDS

Opportunistic Adaptation


City of the Sun
Heerugowaard



Risk vs Resilient-based approach

(to infrastructure design)

Withstand (threshold)

Recover (bounce back)

Adapt (anticipate)

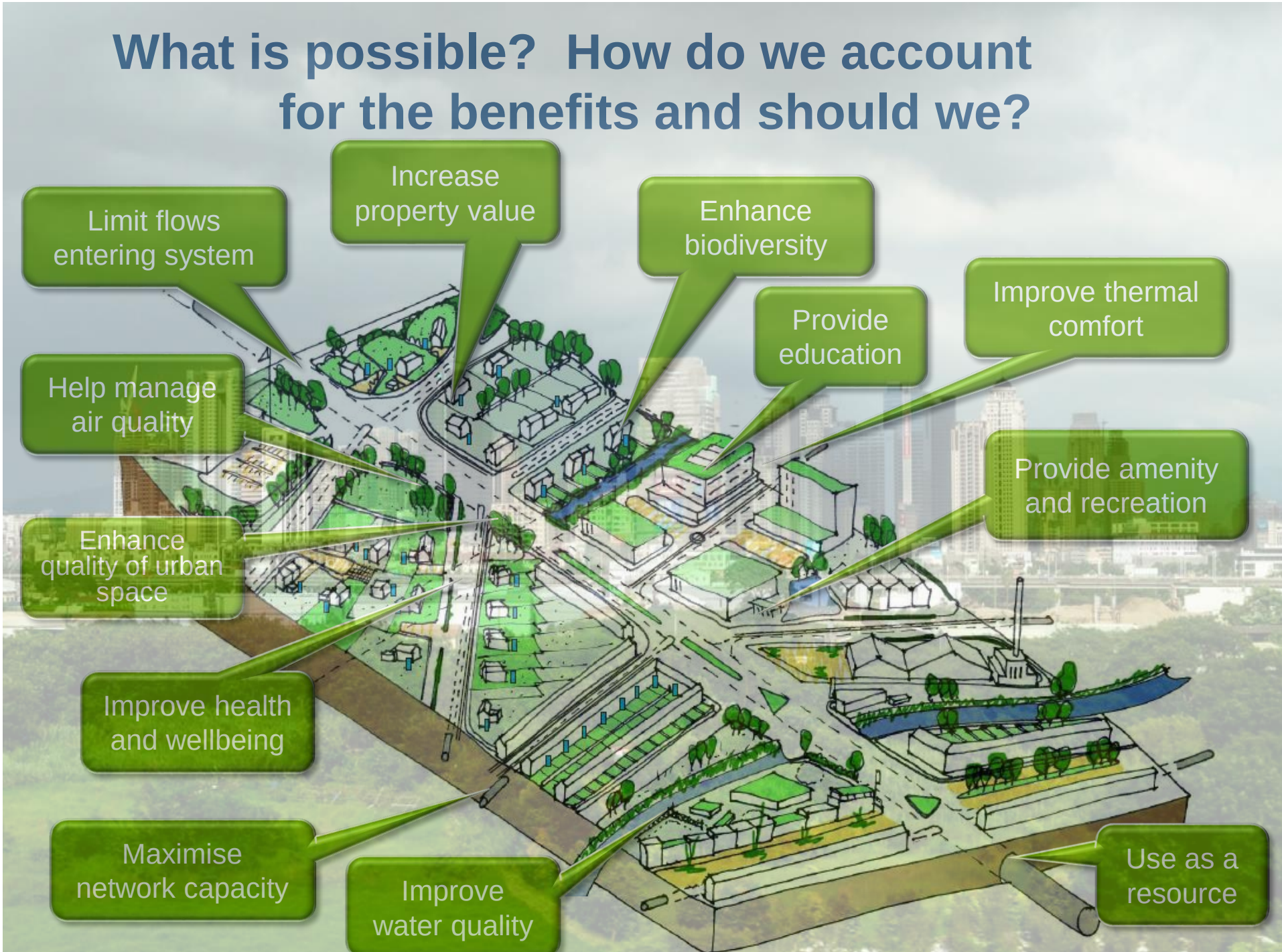
risk-based

resilient-based

Green infrastructure enhances 'urban systems' to withstand, recover and adapt to extreme weather events

GI also create a range of other benefits …..

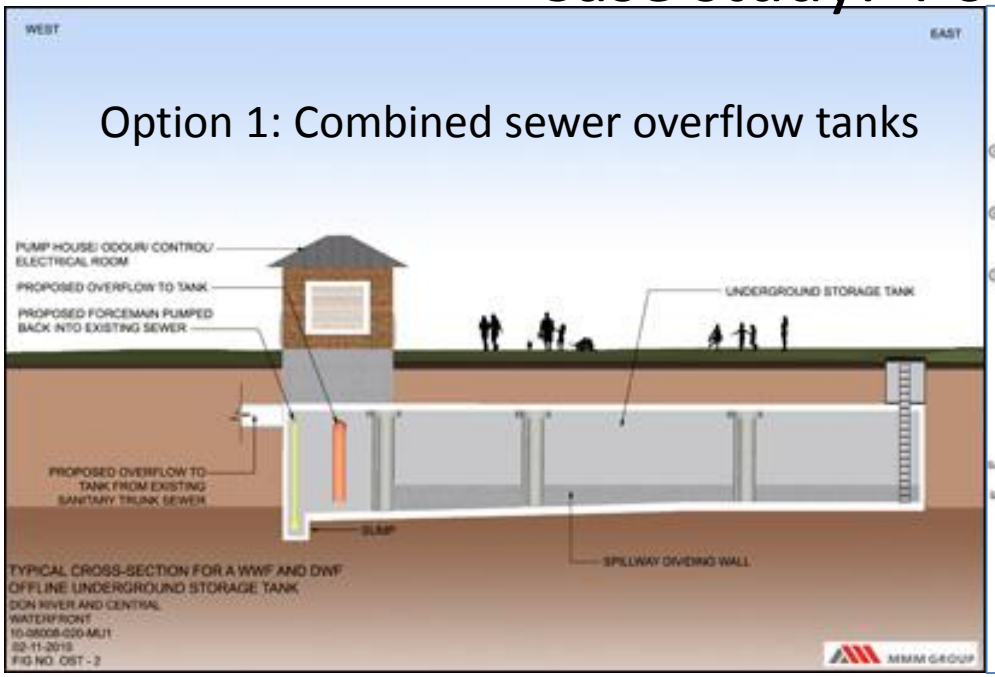
What is possible? How do we account for the benefits and should we?

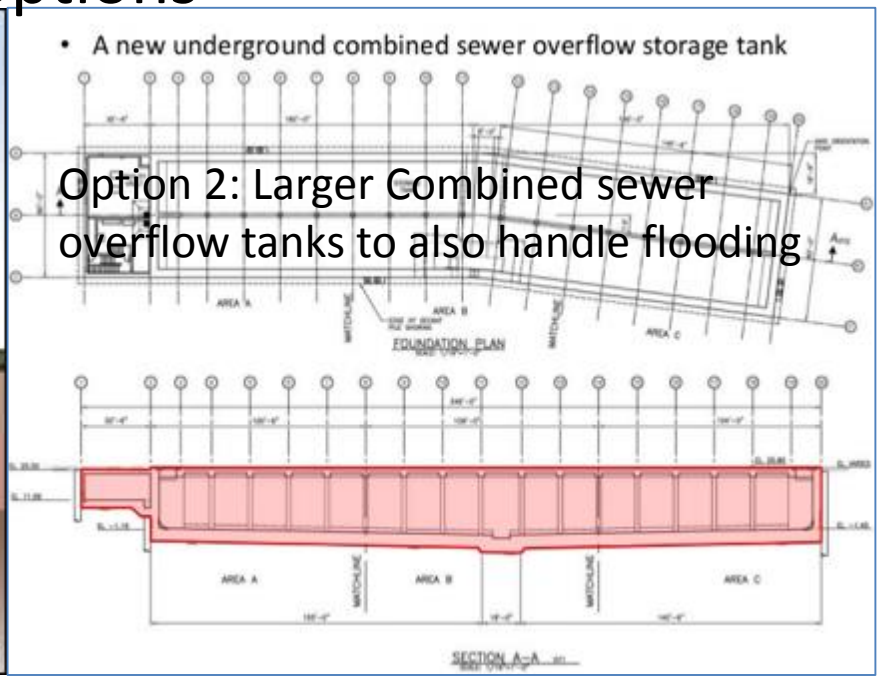


Evaluating the benefits unlocks the potential for…

- Fairer comparisons
- Better decision making
- Meeting funding requirements
- Enabling conversations
- Delivering

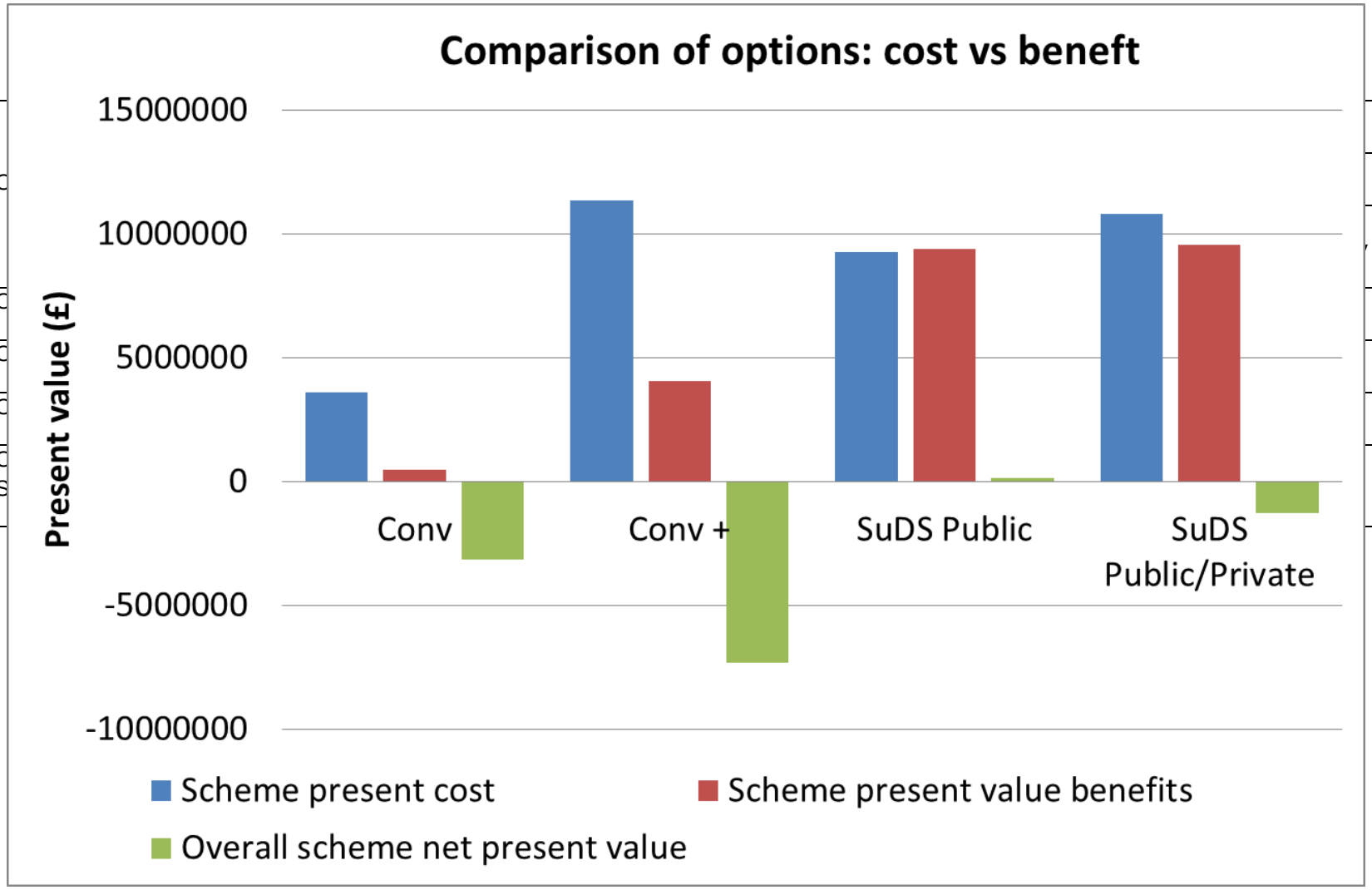
Case study: 4 options



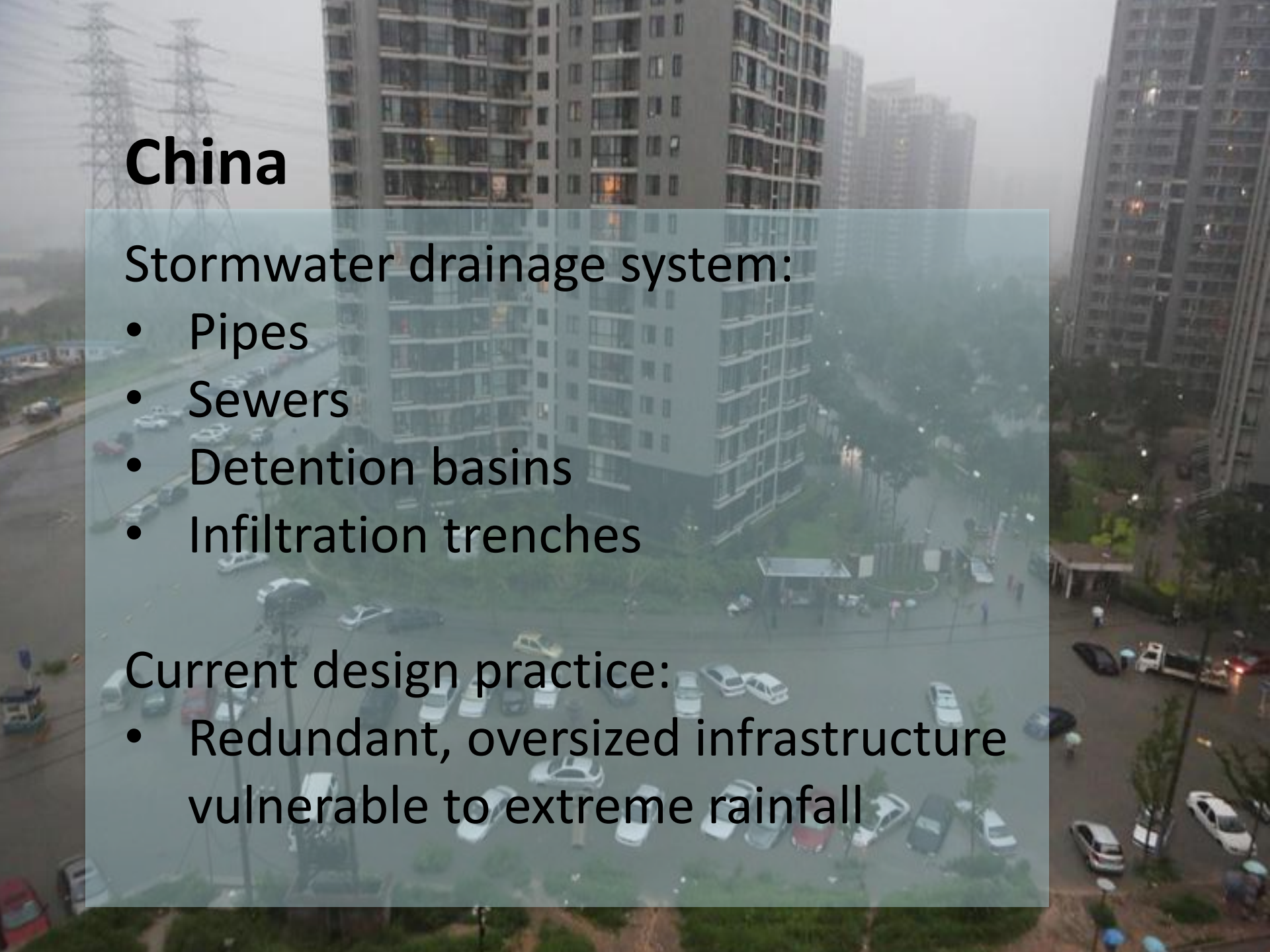


Option 4: LIDs in public spaces and private spaces

Case Study: cost & benefits




China



China

Stormwater drainage system:

- Pipes
- Sewers
- Detention basins
- Infiltration trenches

Current design practice:

- Redundant, oversized infrastructure vulnerable to extreme rainfall

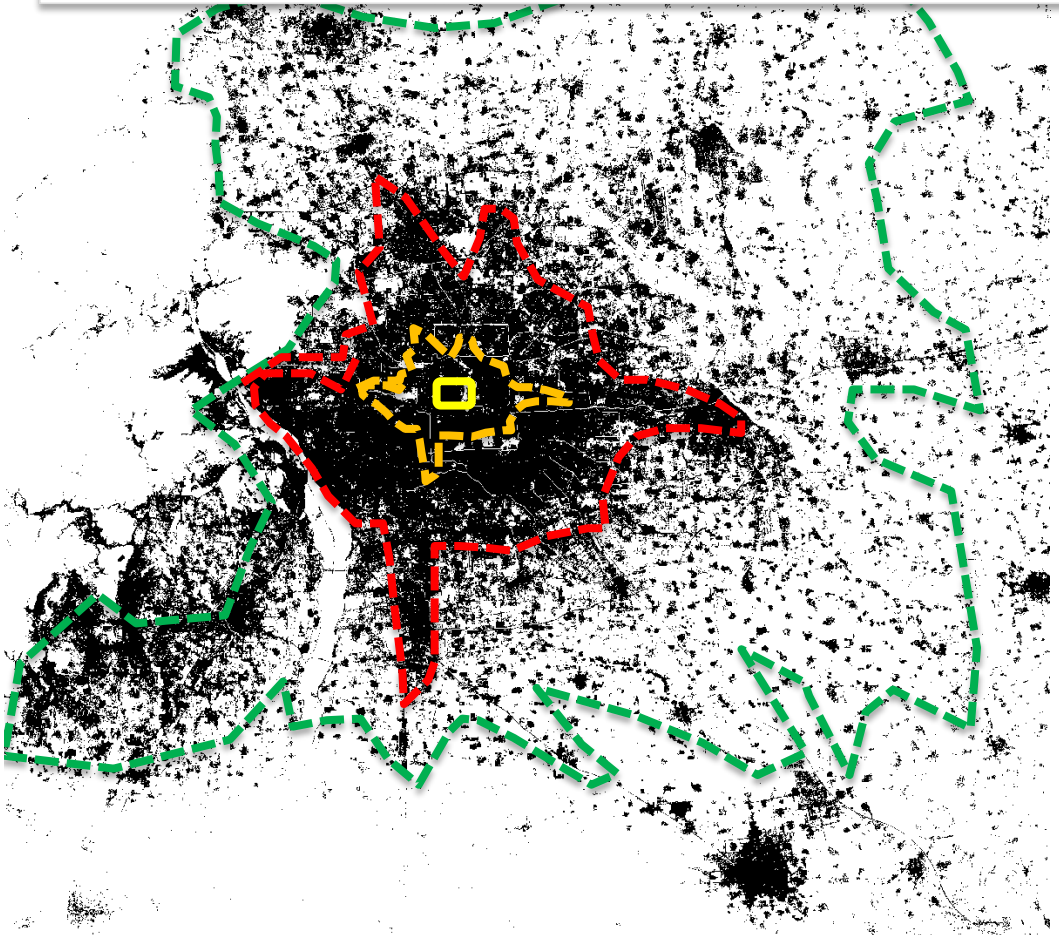
Pilot projects Sponge Cities

- project-focussed, fixed end goals
- promote green infrastructure
- 3 years time frame

Challenges:

- how to transform existing city?
- involvement private sector
- time for reflection (learning)
- Lack of historical data on performance (and costs) of (green) technologies

Transformation challenge typical Chinese City



4th ring: collect and slow down
new developments

3rd ring: collect and slow down
transformation, slow (30 yrs)

2nd ring: accept and accommodate
adapt/retrofitting

1st ring: protect historical centre


Historical city (1st ring):
protect (if needed)


Old city (2nd ring):
Accept and accomodate

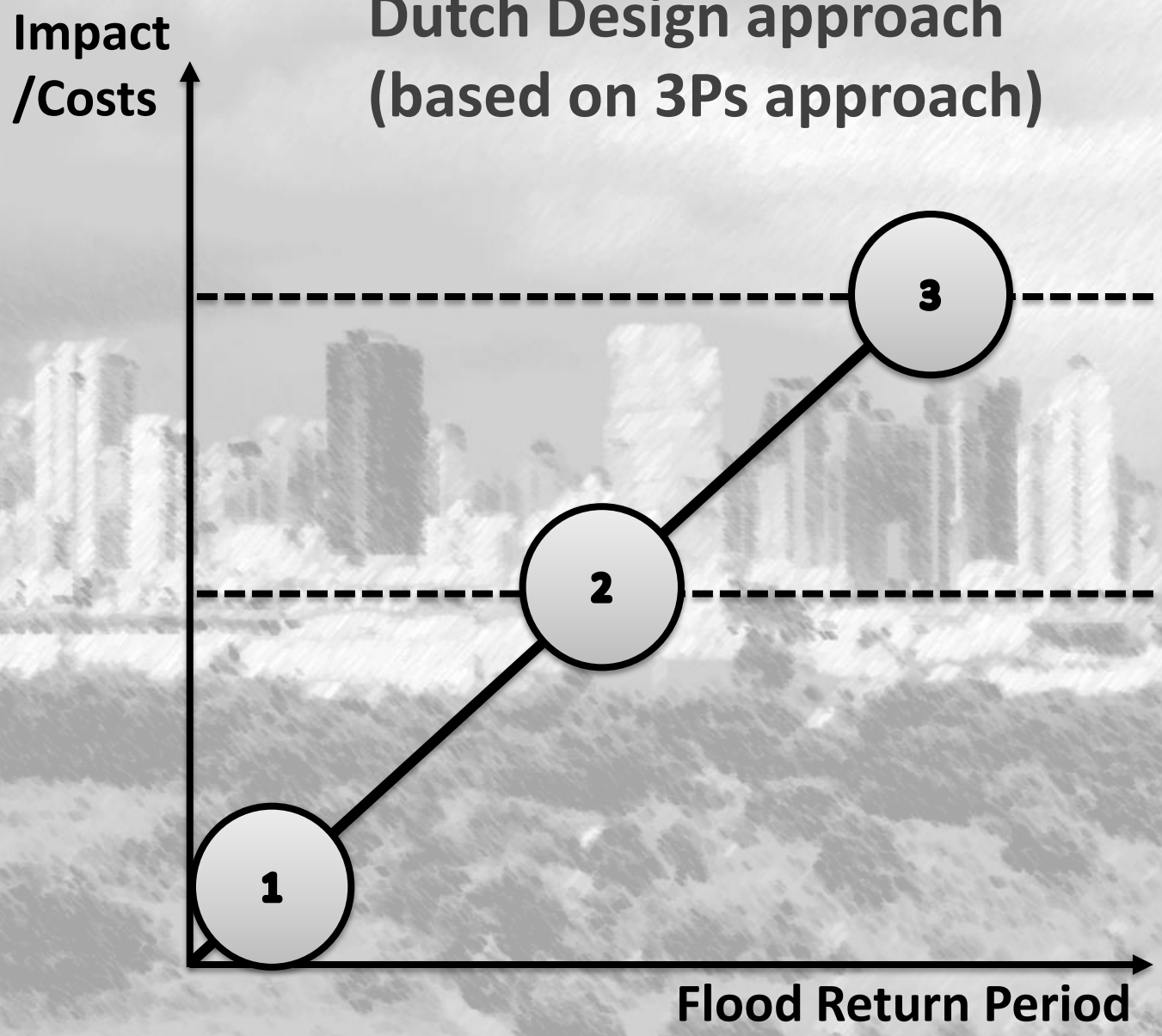
Transformation existing building stock (3rd ring):

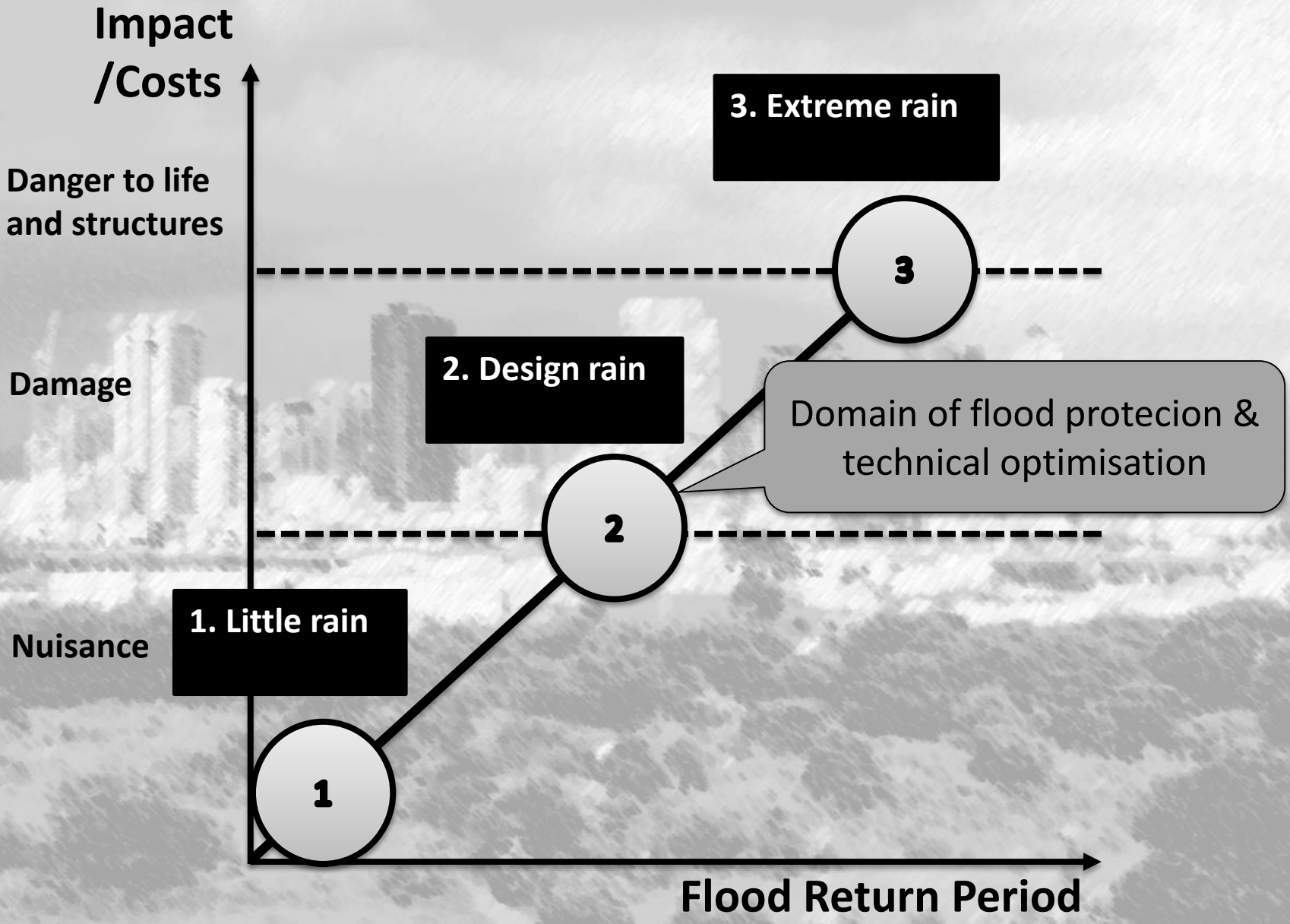
Collect and slow down

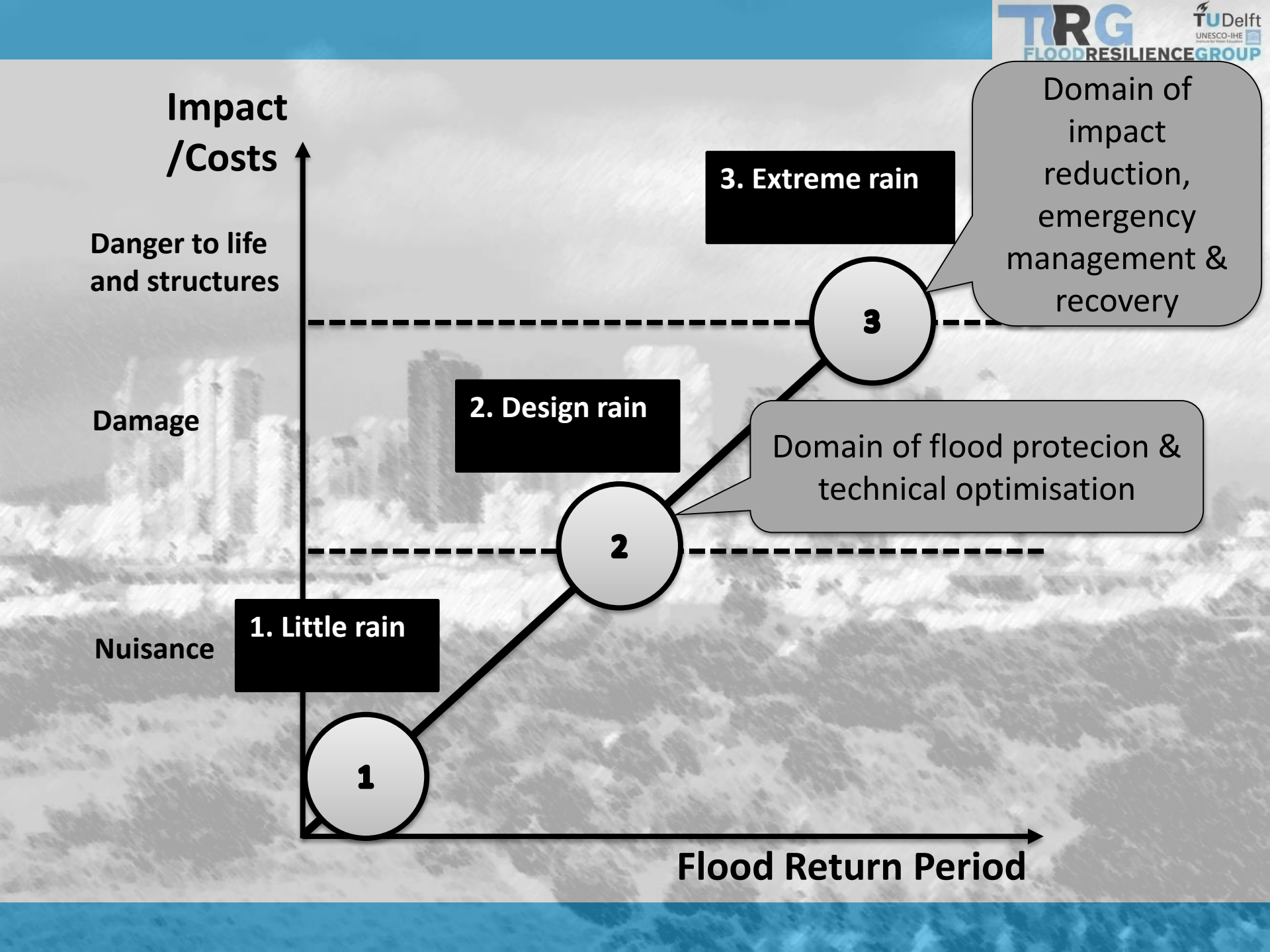
Takes at least one generation

New developments (4th ring):
Collect and slow down
⇒ green infrastructure
⇒ Retention basins

Dutch Design approach (based on 3Ps approach)




Impact /Costs
Danger to life and structures
Damage
Nuisance
3. Extreme rain
2. Design rain
1. Little rain
3
2
1
Domain of flood protecion & technical optimisation
Flood Return Period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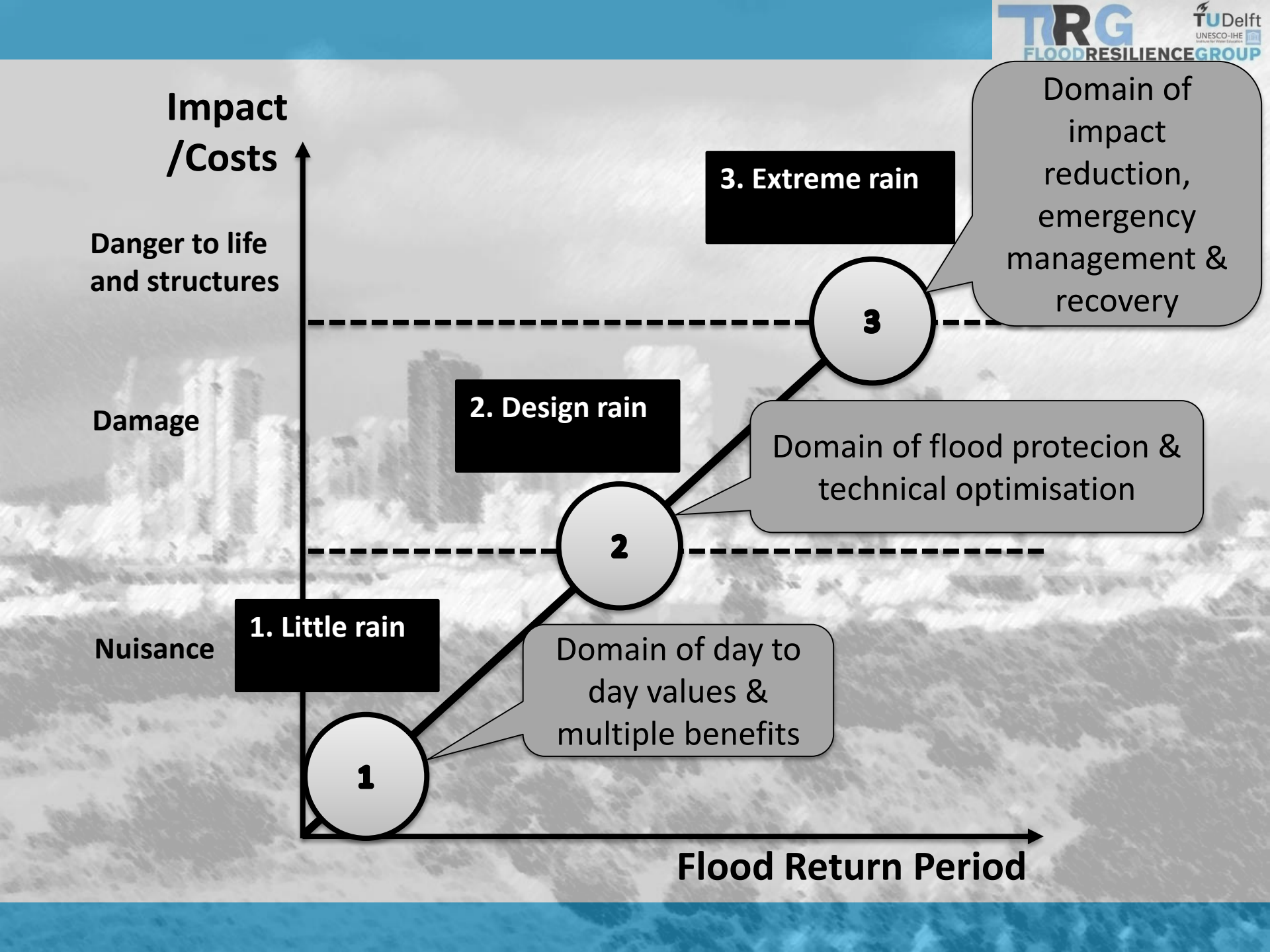
Domain of impact reduction, emergency management & recovery
Domain of flood protecion & technical optimisation
Flood Return Period


Impact /Costs
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1. Little rain
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Domain of day to day values & multiple benefits
Domain of flood protecion & technical optimisation
Domain of impact reduction, emergency management & recovery
Flood Return Period

In conclusion

- From local solution to integrated systems (networks)
- Calls for a new, resilient-based design approach
- Focus on system-wide services (performance)
- Three principles: day-to-day value, standardized events and failure