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Integrated European
Long-Term Ecosystem
Critical Zone &
Socio-ecological Research
Research Infrastructure

Filling a critical gap for top-class science at the continental scale

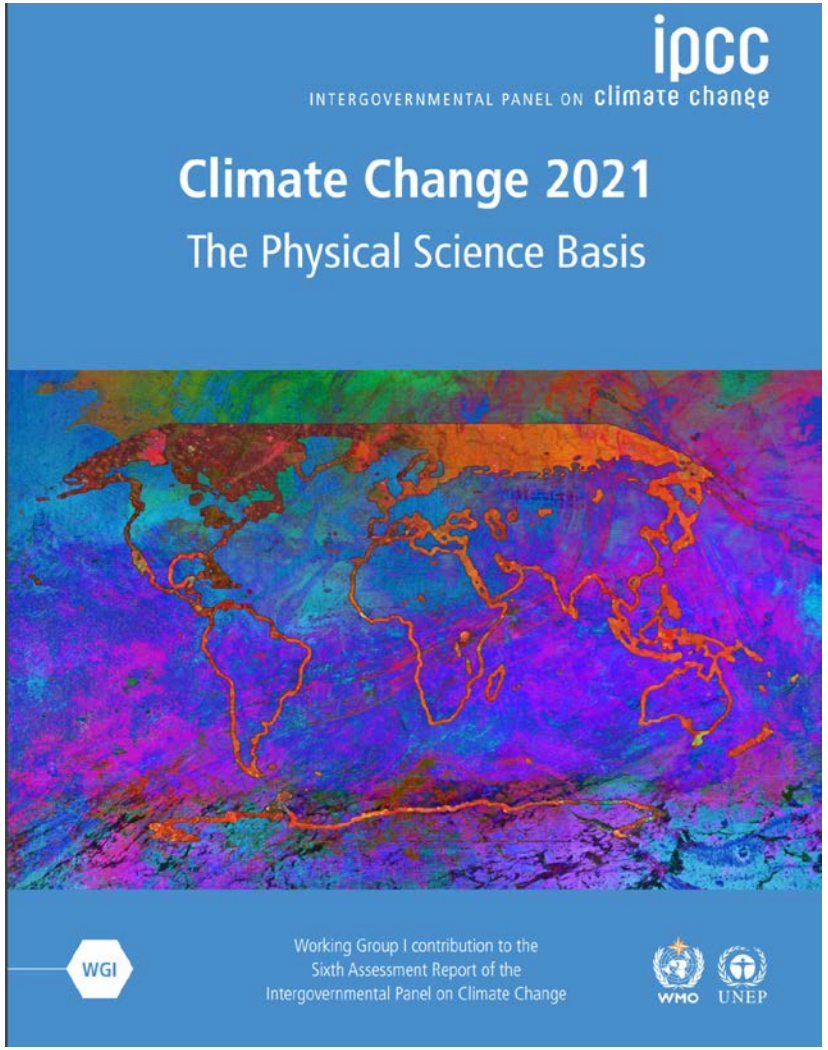
Implementing Nature-Based Solutions: A Road Paved With Challenges

Taiwan International Water Week 2021
Water Resources Agency, Taipei, Taiwan

Technical University Of Crete

Professor Nikolaos P. Nikolaidis

Climate Change and Natural Disasters



➔ The number of **climate-related disasters has tripled** in 30 years.
➔ Between 2006 and 2016, the **rate of global sea-level rise was 2.5** times faster than it was for almost all of the 20th century.
➔ More than **20 million people a year** are forced from their homes by climate change.
➔ The UNEP estimates that adapting to climate change and coping with **damages will cost developing countries $140-300 billion per year by 2030**.

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NBS and the EU Vision

The EU inspires to become a global leader in NBS

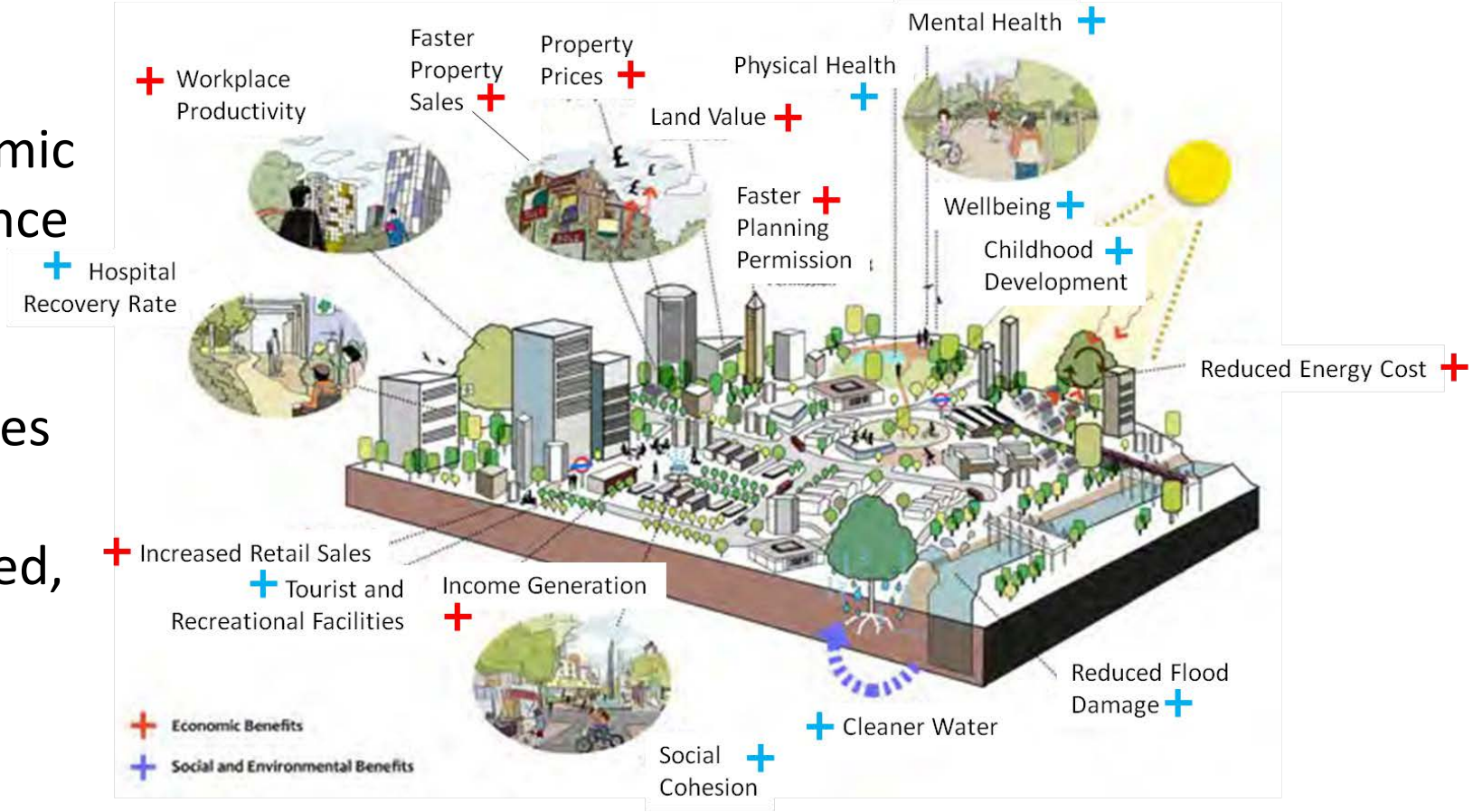
Solutions inspired by NATURE – The Grand Engineer

Nature Based Solutions

Living solutions inspired and supported by nature that simultaneously provide environmental, social and economic benefits and help to build resilience

Solutions that bring more nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions

Green Infrastructure Benefits
(Sustainable Cities Collective – Pinterest image collection)



thinknature

NBS is an "umbrella concept" encompassing other established approaches

Established approaches:

- Climate adaptation approaches
- Community based adaptation
- Ecosystem based adaptation
- Ecosystem based management
- Ecosystem based mitigation
- Ecosystem based disaster risk reduction
- Ecological engineering
- Ecological restoration
- Infrastructure related approaches
- Natural resources management
- Sustainable agriculture/agro-forestry/aquaculture

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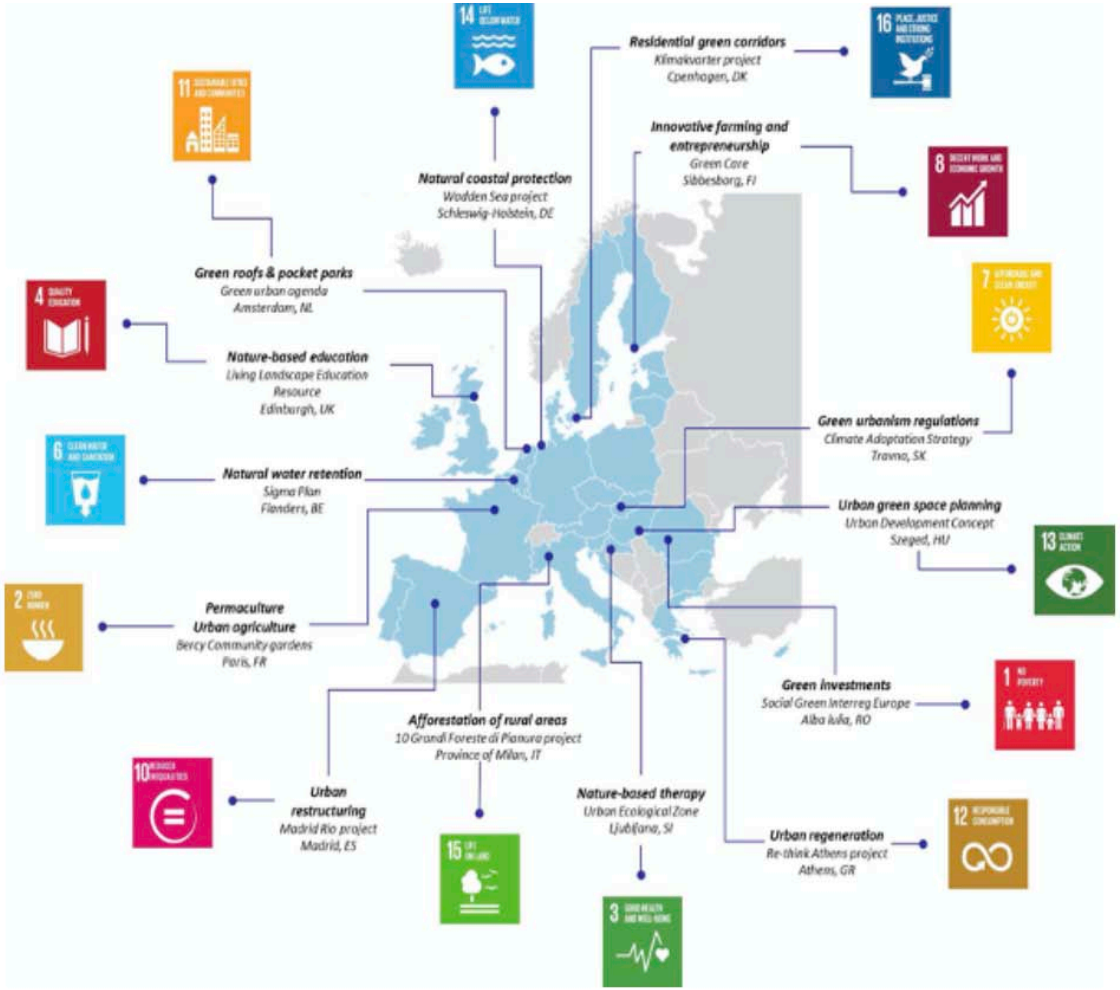
SDGs and NBS challenges to be solved



NBS challenge to be solved/SDGs:

- Climate mitigation and adaptation
- Water management
- Coastal resilience
- Green space management
- Air Quality
- Urban regeneration
- Participatory planning and governance
- Social justice and social cohesion
- Public health and well-being
- Potential of economic opportunities and green jobs

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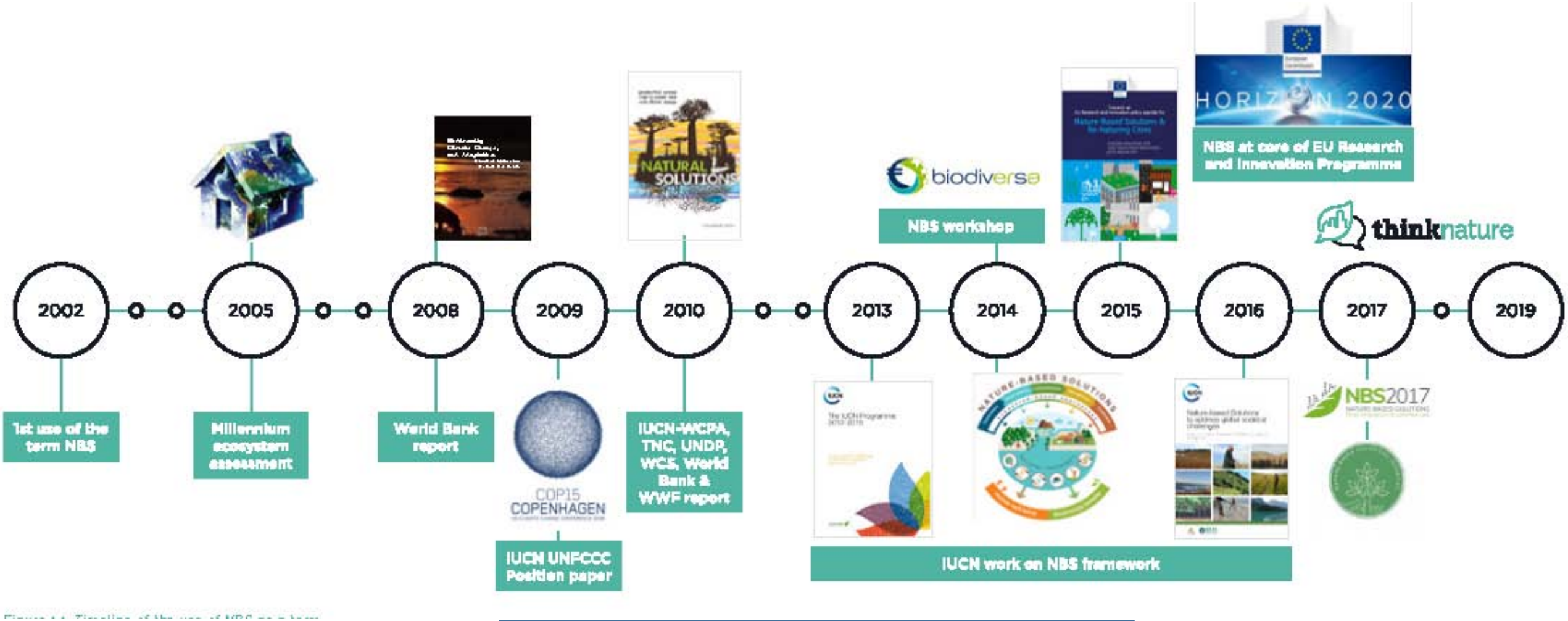
Timeline for the evolution of NbS



- Urban resilience and risk management
- Socio-economic and environmental outcomes
- Climate Change adaptation and mitigation
- Sustainable development
- Biodiversity

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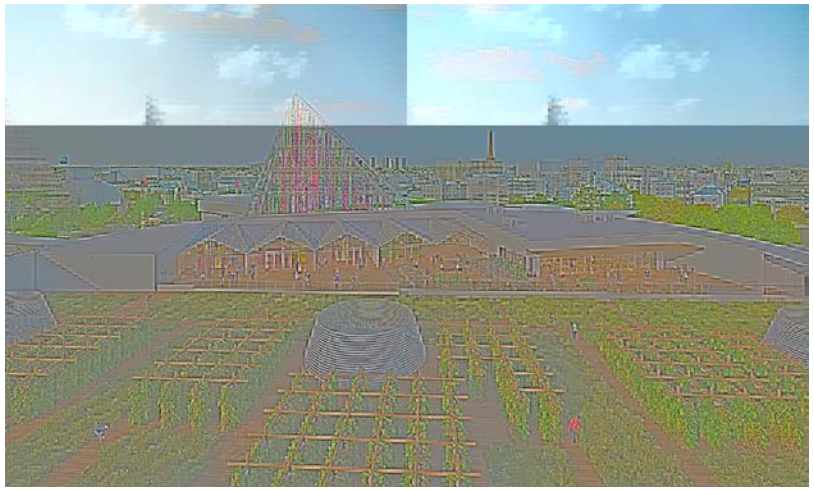
NBS – Global and EU Related Policies



The new rooftop farm in Paris will be the largest of its kind in the world. Photograph: Valode & Pistre Architectes Atlav AJN

Policy area	Global policy	EU policy
Cross-cutting	• 2030 Agenda for sustainable development, Sustainable Development Goals (2015) • United Nations (UN) Convention to Combat Desertification (1996) (a)	• European Green Deal (2019) • Bioeconomy strategy (2012) and its update (2018)
Biodiversity (including forestry)	• UN Convention on Biological Diversity (1993) (a) • Ramsar Convention (1975) (a)	• Biodiversity strategy for 2030 (2020) • Green infrastructure strategy (2013) • Habitats Directive (1992) • Birds Directive (1979/2009) • EU forest strategy (2013) • LULUCF Regulation (2018)
Climate	• Sendai Framework for Disaster Risk Reduction 2015-2030 (2015) • UN Framework Convention on Climate Change (1994) (a), Paris Agreement (2015)	• Action plan on the Sendai Framework for Disaster Risk Reduction (2016) • Strategy on adaptation to climate change (2013, 2021)
Water and agriculture		• Farm-to-fork strategy (2020) • Floods Directive (2007) • Water Framework Directive (2000) • Common agricultural policy (2013) • Nitrates Directive (1991)
Urban	• New urban agenda – Habitat III (2016)	• Urban agenda for the EU (i.e. Pact of Amsterdam, 2016)

Note: (a) The original agreements/treaties, as well as relevant subsequent conclusions, resolutions and decisions, were reviewed. LULUCF, Land use, land use change and forestry.

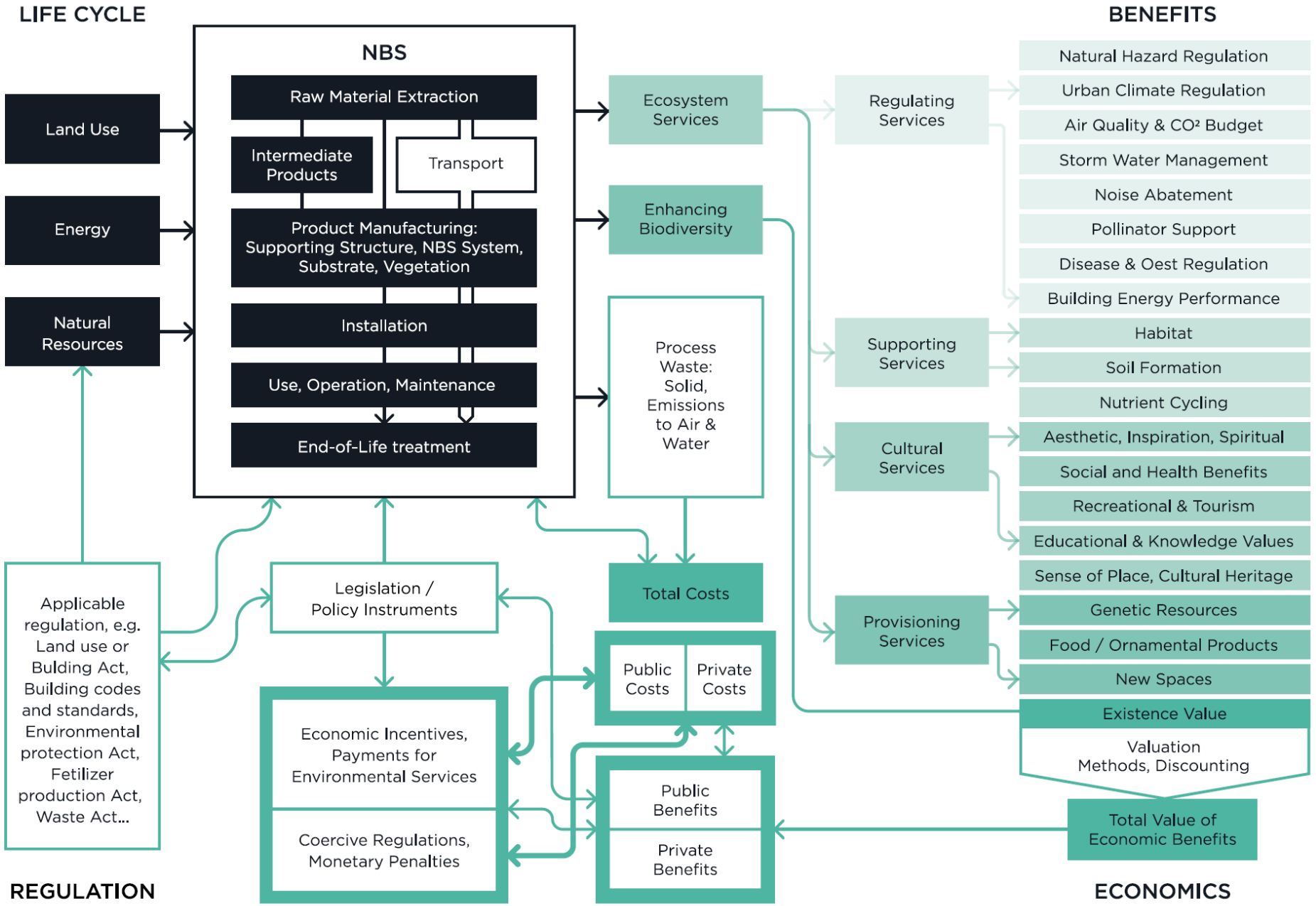
Source: EEA.

Challenges to successful implementation and upscaling

Nature-based projects and uncertainty

- NBS are inherently complex & uncertain
- External events (NBS drivers) are also uncertain
- NBS design should respond to a **dynamic and highly complex context** and the process should be open and transparent
- **Co-benefits** of NBS may be only indirectly related to the goals **Life-cycle costs** need to be considered in the business case

Systemic approach of NBS depicting utilities & environmental impacts



NBS Implementation Steps – Adaptive Management

Planning stage

1. Outline the problem
2. Involve stakeholders
3. Scoping analysis
4. Alternatives
5. Preliminary assessment

Yes/No?

Implementation stage

6. Detailed design
7. Assessment
8. Bsns case/financing
9. Implementation
10. Monitor (feedback)

Adaptive Management

Feedback and iteration are decisive characteristics that distinguish NBS logic and decision making from projects using grey elements or grey infrastructure.

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Barriers for successful design, implementation & upscaling of NBS

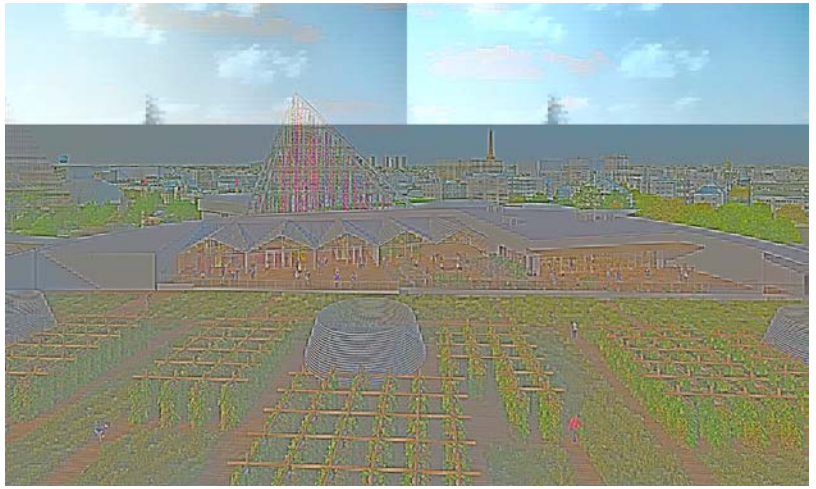
Technical barriers

- **Technically feasible solutions** appropriate for addressing multiple challenges are limited & underdeveloped
- **Lack of** sufficient **guidance-protocols** & technical support in terms of instructions for implementation & maintenance
- **Materials** used for NBS are not always environmentally friendly
- Lack of ready to use and easy to install **technical products**

CityTree in Copenhagen (https://greencitysolutions.de/en/)

Barriers for successful design, implementation & upscaling of NBS

Technical barriers



The new rooftop farm in Paris will be the largest of its kind in the world. Photograph: Valode & Pistre Architectes Atlav AJN

- **Expensive technology** stands at the cross-section of the technical and market spheres
- **Restrictions** of the monitoring methodologies **to link NBS impacts across spatial scales** (micro to regional)
- **Poor availability** of consistent **datasets to evaluate** NBS impacts
- Accuracy and quality of the **monitoring approaches**
- **Quantification of the impacts** of heat and drought on NBS and their capacity to continue to provide services

Barriers for successful design, implementation & upscaling of NBS

Knowledge gaps

- **Lack of** deep **understanding** among multidisciplinary key actors
- **Lack of** appropriate **training** of planners, developers & construction professionals
- **Lack of interdisciplinary skilled personnel**
- **Absent** in-depth **stakeholder mapping** & outreach
- **Absence** of a widely established holistic **framework** for the assessment of NBS impacts
- **No data** on real **maintenance costs**

Vertical Forest realized in the centre of Milan
Architect Stefano Boeri

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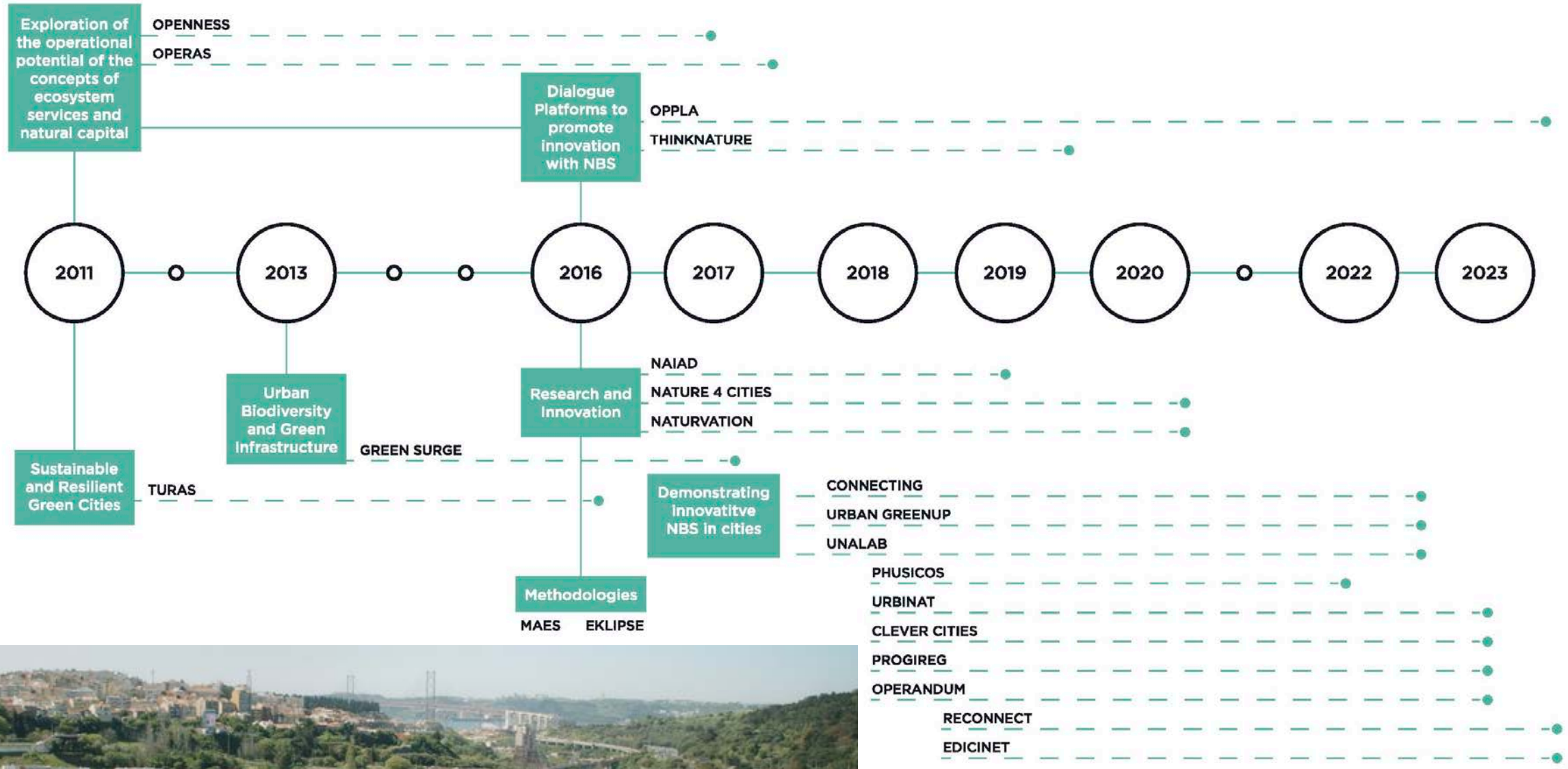
Barriers for successful design, implementation & upscaling of NBS

Knowledge gaps

Park Spoor Nord in Antwerp

- **Lack of evidence** regarding the quantitative **benefits** of NBS
- **Lack of knowledge** regarding the impacts of NBS on health & wellbeing
- **Insufficient**/ absent follow-up **monitoring** of implemented NBS impeding the evaluation of NBS effectiveness
- **Uncertainty** about temporal evolution & **long-term effects** of NBS
- **Interdisciplinary methods & research** designs to monitor synergies and trade-offs within and across challenges

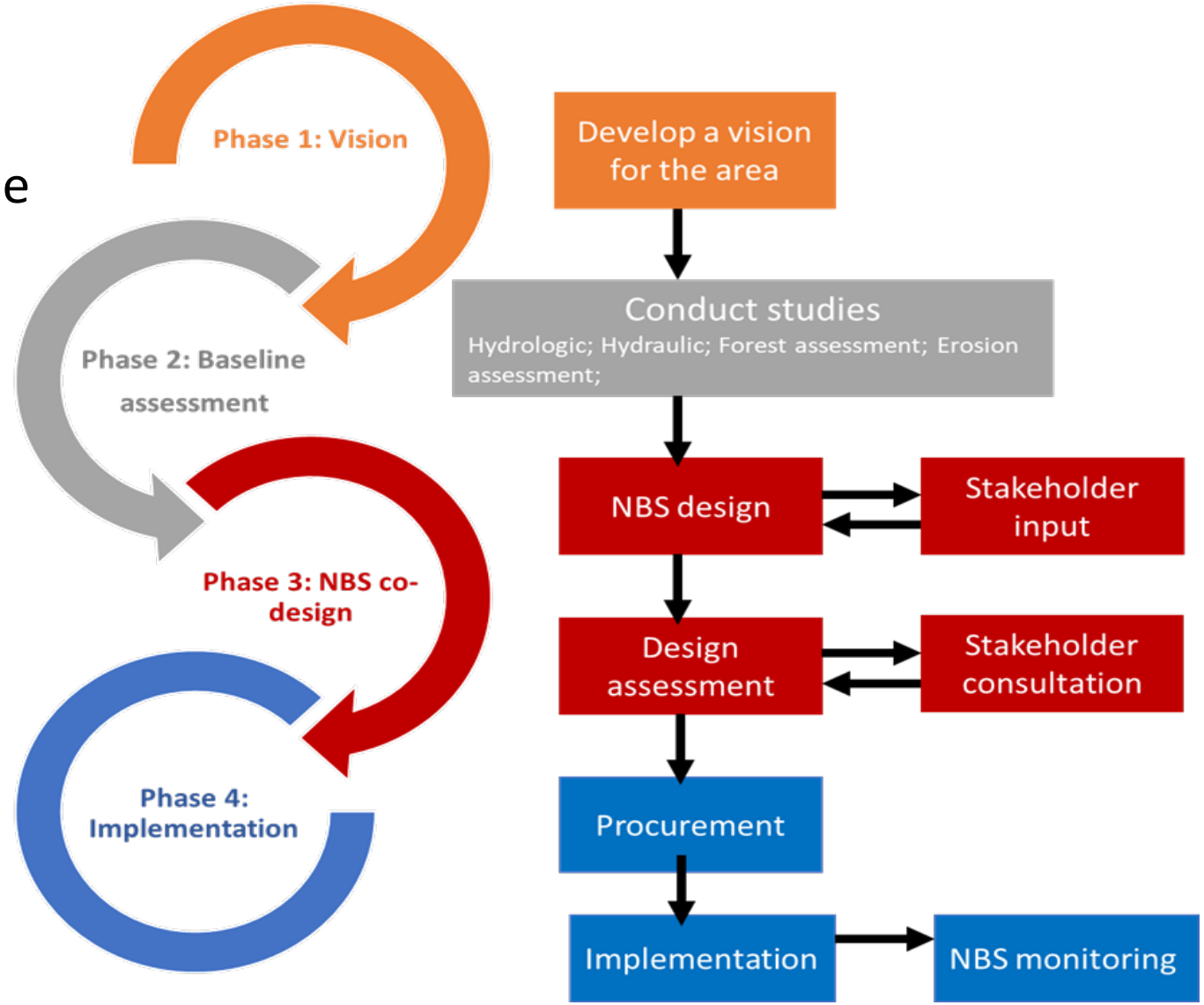
There is hope – more than 300 M€ knowledge generation



How is an NBS Initiated?

Decision-making methodology scheme for NBS implementation

Develop a vision-based decision-making approach to designing and implementing NBS that would act as a driver to overcome potential barriers and enhance the social acceptability of the project.



Copenhagen Cloudburst Management Plan

Location

Copenhagen, Denmark

Region

Northern Temperate

Ecosystem

Urban

Goals

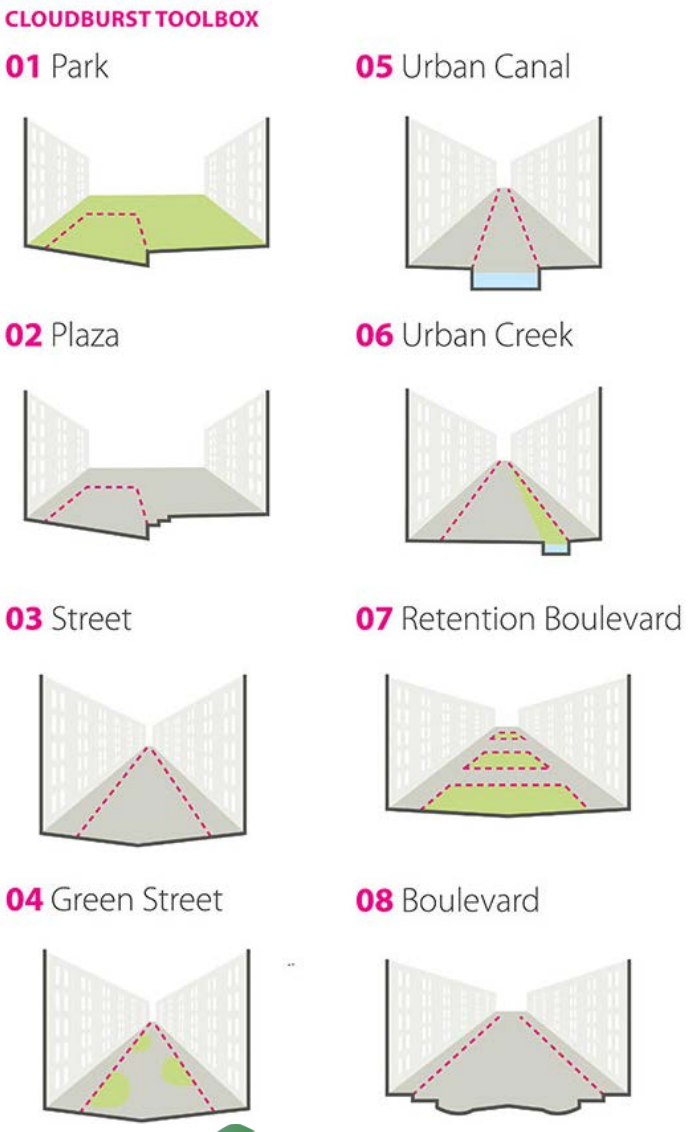
- Enhancing sustainable urbanisation
- Developing climate change adaptation; improving risk management and resilience

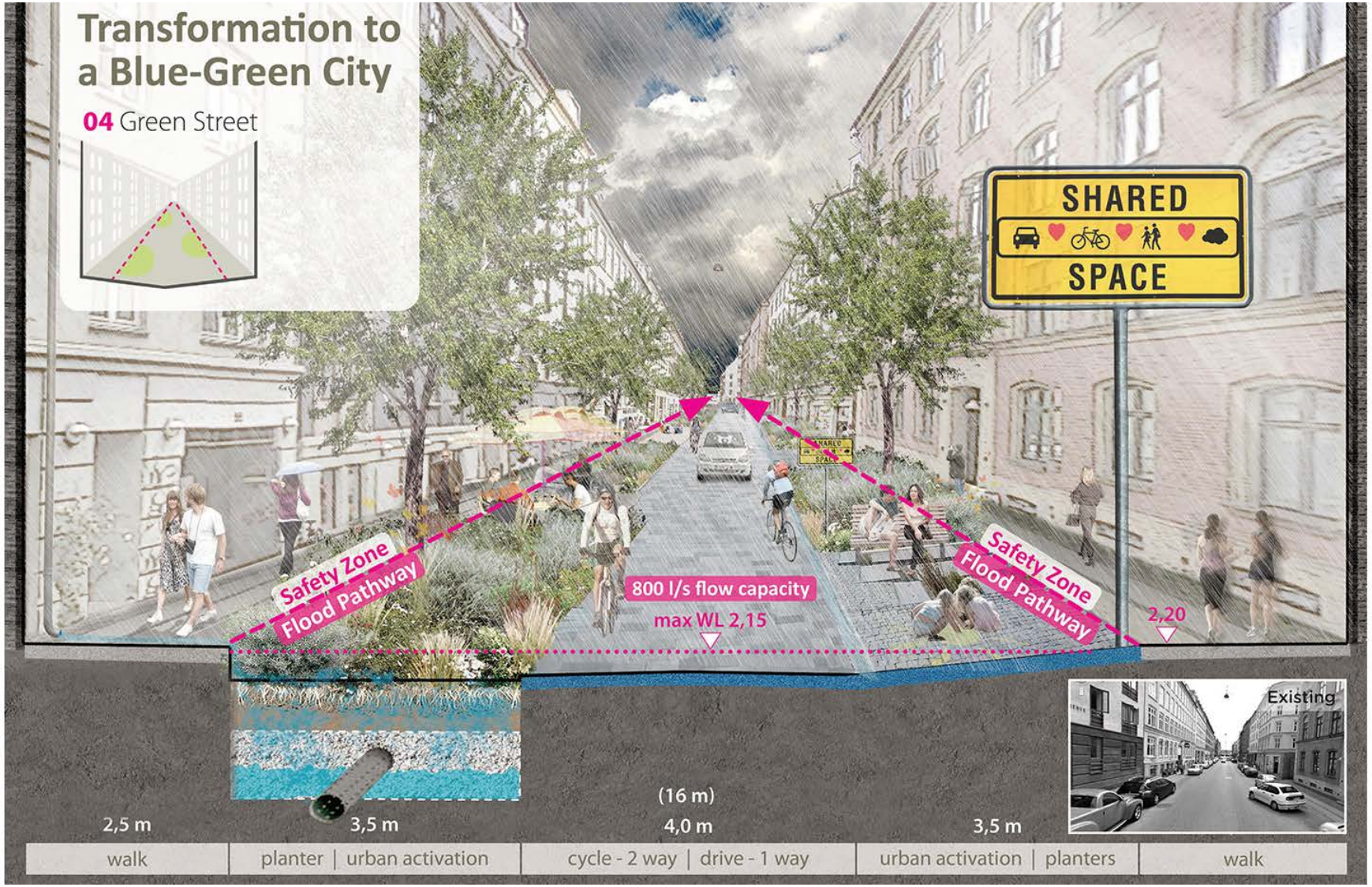
Action

Nature-based solutions and the insurance value of ecosystems

Photo Credit: Ramboll and Ramboll Studio Dreiseitl

Copenhagen Cloudburst Management Plan

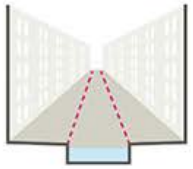


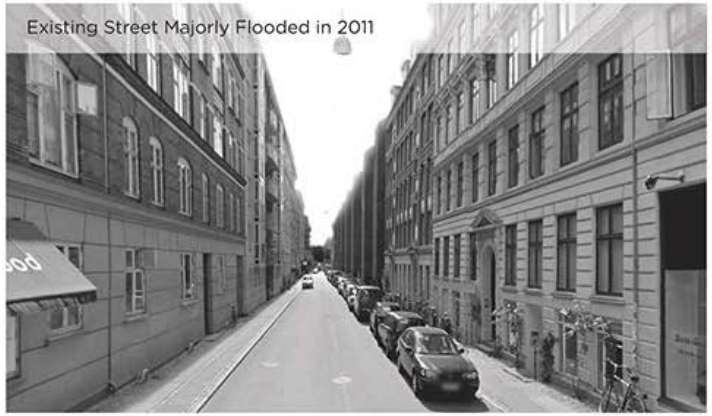


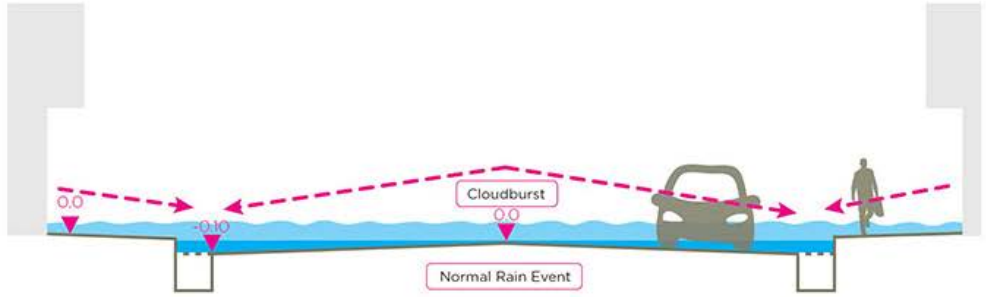
Photos Credit: Ramboll and Ramboll Studio Dreiseitl

Copenhagen Cloudburst Management Plan

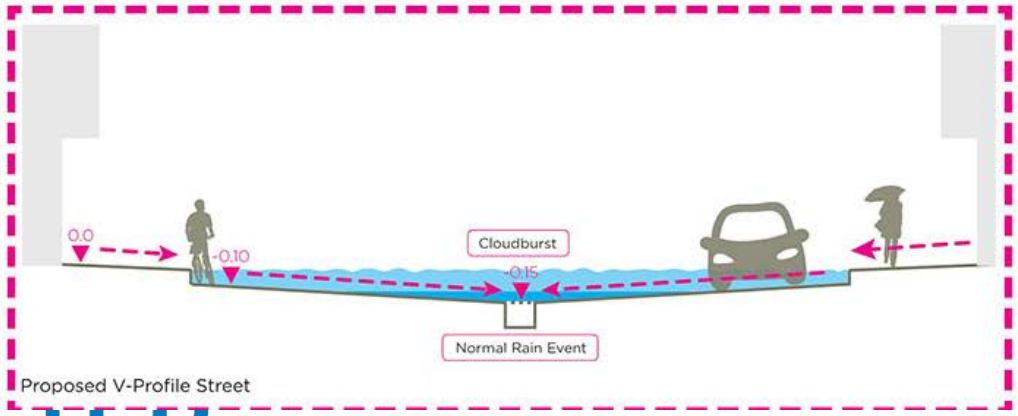
05 Urban Canal



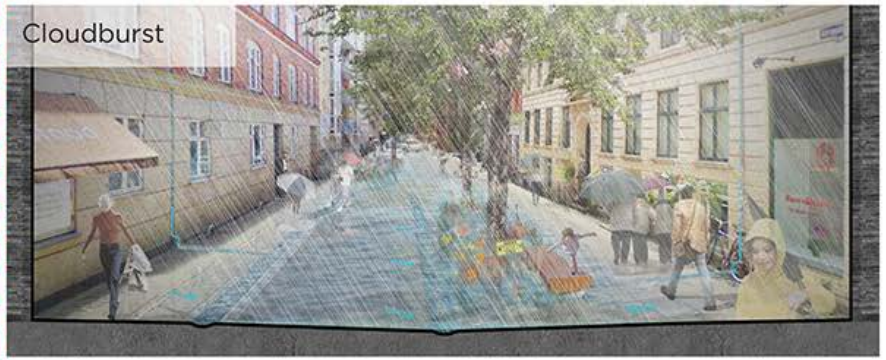




Conventional: Existing Crowned Street



Proposed V-Profile Street



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Photos Credit: Ramboll and Ramboll Studio Dreiseitl

Copenhagen Cloudburst Management Plan

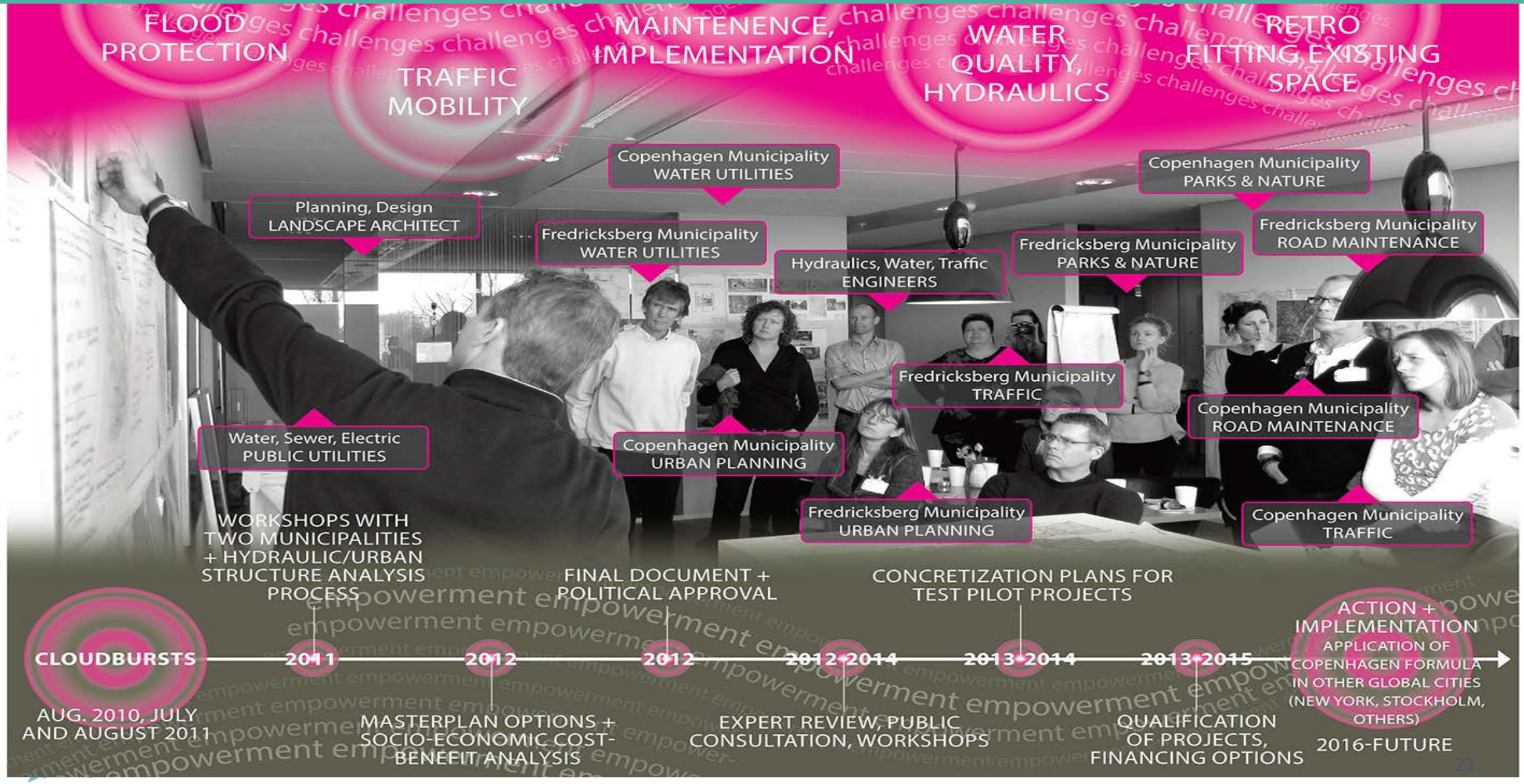


Photo Credit: Ramboll and Ramboll Studio Dreiseitl

Opening up of Cheonggyecheon River in Seoul

Before Restoration

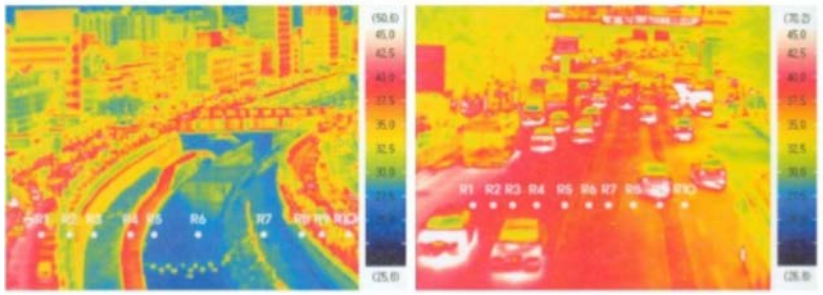
- Densely populated area
- Deterioration
- Blocking of natural water circulation

Motivation for NBS

- Creation of nature and human centered city space
- Rebuilding Seoul's 600 year old historical and cultural heritage (historic bridges, latern festival etc)
- Economic revitalization of downtown area

Opening up of Cheonggyecheon River in Seoul

Thermal Images, September 8, 2005



KEY ELEMENTS AND DRIVERS FOR SUCCESSFUL PRACTICES IN THE IMPLEMENTATION AND UPSCALING OF NBS

IDENTIFY AND PRIORITISE CHALLENGES AND GOALS

Co-define primary goals and priorities, weighting the input from all affected parties

Evaluate anticipated benefits, co-benefits and trade-offs to make informed decisions

Consider the optimisation of various benefits simultaneously, taking into account the implementation context

Reach concensus, reconciling conflicting goals and interests

Prepare to cope with complexity and ambiguity of the addressed challenges

NBS design and implementation to include multiple goals whose effectiveness can be measured

Provide appropriate training regarding emerging techniques to planners, developers, and construction professionals

MAKE OPTIMAL USE OF AVAILABLE KNOWLEDGE, TECHNICAL SOLUTIONS AND TECHNOLOGIES

Enable multi- and transdisciplinary knowledge exchange and co-design for a mutual understanding of the available alternatives, their costs and their impacts

Promote design and testing of applied technologies in NBS, through innovative collaboration with engineers, scientists and academics regarding novel technologies

Chose technical products that are ready to use and easy to be install to reduce the cost of NBS and promote further adoption.

Technical knowledge from architects and engineers to be interlinked with knowledge on social and environmental systems for optimum synergies

Provide technical support for the construction and implementation of NBS

Use Cultural Heritage as a source of inspiration for renaturing Cities through the use of historical technologies

Digitisation or smart technologies support cost-efficiency as these can reduce maintenance costs, e.g. via automated irrigation systems

Use technology applications to inform and increase public awareness regarding challenges addressed and the effectiveness of NBS (e.g. smartphone software)

Quadrant analysis and time-lapse photography are effective solutions for ecosystem-based NBS monitoring

CONCEPTION EVALUATION

Even across scales, stakeholder involvement enables knowledge exchange and co-creation

Stakeholder mapping and engagement

Recruit local partners to ensure efficient interaction with local administration

Take into account insights of all interested parties early on to enable informed decisions, optimise planning and ensure general acceptance

Build on the input of experts from different disciplines and scientific domains

Ecological and other natural sciences to offer innovative NBS and also evaluate the outcomes

PLANNING

Work with citizens on the design and management of temporary uses of vacant spaces

Facilitate the exchange process to engage all into a constructive dialogue

Engage with networks that have created or have acquired experience implementing NBS

Promote sense of ownership

Implement open space strategies that aim to increase accessibility for citizens and ensure quality (e.g transform schoolyards into cool islands, open to the community)

Social and Economic sciences to facilitate and support stakeholder involvement and evaluation of NBS

Green roofs:
- use soils derived from local area,
- adopt a growing medium depth of min 10 cm,
- structure short mounds (height: 30 cm – width: 3 m) as habitat of many living species,
- plant mixed types of native vegetation,
- involve authorities and experts in planning and implementation stages, for extensive roofs

IMPLEMENTATION

Ensure the sustainability of NBS

Careful selection of materials (locally sourced, reused, recycled, with minimum eco footprint)

Provide technical instructions with lists of suitable plants (organisms) for the local conditions and instructions for their maintenance

Provide instructions on how to avoid invasive species, and guidelines to use invasive species databases, such as www.nobanis.org/

Pursue thorough formal assessment for large scale NBS

Monitor and assess

Define appropriate criteria that will enable measuring of the success towards the pre-defined goals. Criteria should assess the ecological, social, and economic performance of the applied solutions

LCA, MIPS, or other overall system cost-benefit and environmental evaluation should be a basic requirement for all NBS to ensure their overall sustainability

Ensure long term monitoring especially for large scale NBS as there are long term effects that need to be taken into account

CITIZEN PARTICIPATION FOR BETTER COMPREHENSION OF RISKS AND CONFLICTING EFFECTS

ADAPTABILITY TO THE CONTINUOUS ECOLOGICAL, ECONOMIC AND SOCIAL CHALLENGES

FLEXIBILITY WHEN IT COMES TO RE-EVALUATING GOALS AND PROPOSED ACTIONS

SUCCESSFUL IMPLEMENTATION OF NBS

KNOWLEDGE BASE

Create a solid technical knowledge-base through demonstration projects to support NBS and also help in estimating costs of alternatives.

Handbooks for action containing: info on who should be involved, financing opportunities, instructions for applying resources and evaluation of outcomes.

Implement formal assessment of technical performance alongside life-cycle cost (installation, running and maintenance costs) to showcase the effectiveness of NBS

Key actors for the upscaling of NBS: municipalities, state authorities, research organisations, NGO, EU

Support NBS innovators at EU, national, regional, and local levels to overcome technical barriers

Effectively disseminate knowledge of existing technical solutions e.g in exhibitions, conferences, and other events

Establish a common protocol for design, implementation, and maintenance of NBS for academia, business, and NGO

Integrate follow-up monitoring in the organisational culture of financing bodies

Information on unsuccessful projects is equally useful in terms of improving practice. Such examples help address barriers and build confidence among stakeholders

TRANSFERABILITY & REPLICATION OF NBS

"The knowledge and experience derived from planning, implementation, and impact assessment stages of various NBS case studies is a valuable resource for future relevant initiatives"

The lack of evidence base and the misperception of benefits, technical inadequacy, governance barriers, economic barriers, reduced participation, and awareness, are barriers that impede the uptake of NBS. These aspects, once properly addressed, can become drivers that promote wide adoption of NBS.

Instead of conclusions

Imagine Transformative Change

- Fully understand the extend of the multi-dimensional impacts of the problem at hand
- Create a VISION for “transformative change” – the big picture
- Involve key stakeholders – buy in of the vision
- Start the journey – good luck

Vincent van Gogh, Starry Night (1889)

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www.koiliaris-czo.tuc.gr
platform.think-nature.eu
Gracie Mille
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How to design and implement Nature-based Solutions (NBS)

Taiwan International Water Week 2021
October 15th, Taipei

Tom Wilms MSc

How to design and implement Nature-Based Solutions (NBS)

- Introduction
- Building with Nature approach

  Methodology to design and implement Nature-Based Solutions
- Case study: city at the river
- Background information
- Key messages

Introduction

Tom Wilms MSc

Expert Nature-Based solutions and ICZM

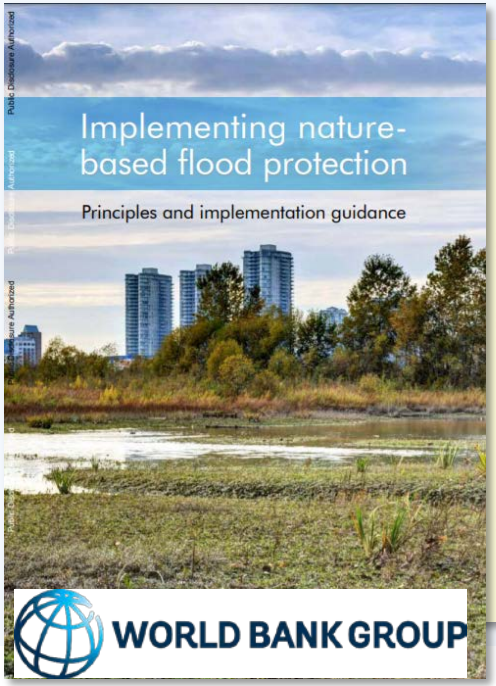
15 years experience (4 years in Indonesia)

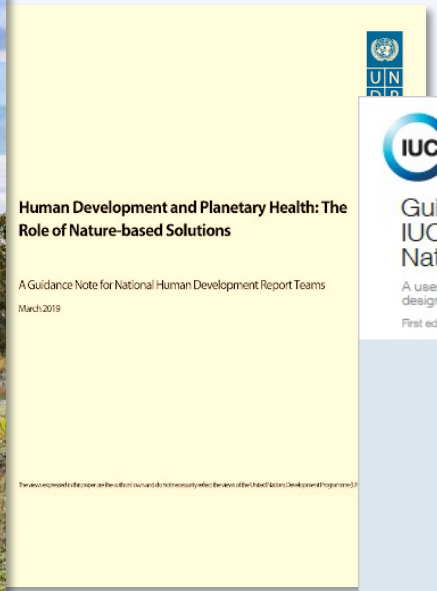
Witteveen and Bos 1946

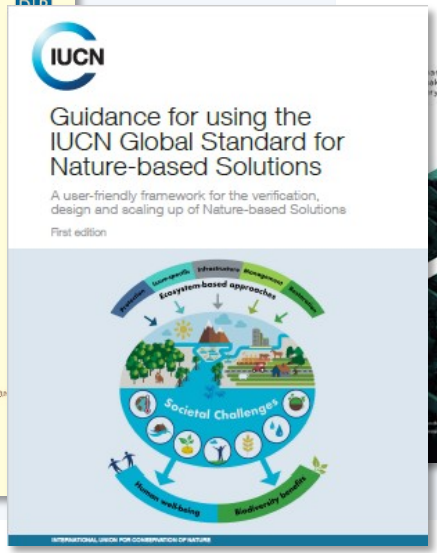
- Witteveen (54): director GW Rotterdam
- Bos (37): civil engineer at GW Enschede
- Consulting engineering company Witteveen+Bos
- First project: Prins Bernhard lock Deventer
- Growth:
  - 1994: 500 employees
  - 2014: 1.000 employees
  - 2021: 1.350 employees
- Independent and 100% ownership
- 9 offices in the Netherlands
- 13 offices international
- Sustainability and innovation

Business lines

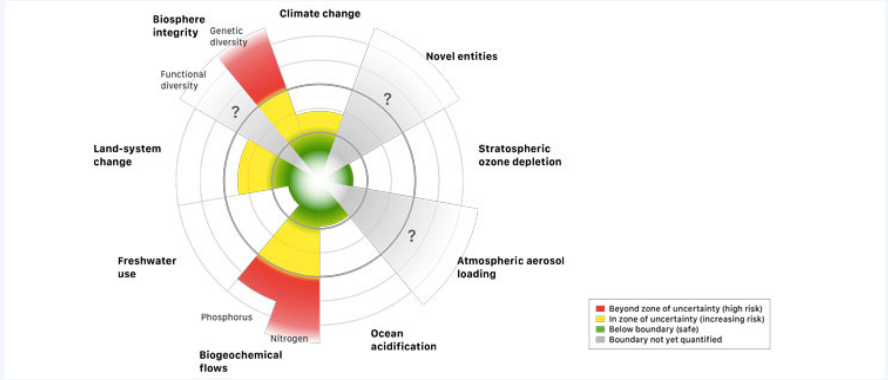
Global trend: Nature based Solutions for climate resilient infrastructure







Meeting the Global Goals within the planetary boundaries



Nature Based Solutions are

… dynamic

… multi-functional

… innovative for dealing with water issues

… local and context-specific

You need to **think, act** and **interact** differently!

EcoShape | Building with Nature

Since 2008:

- Sectors *collaborating* with a shared ambition
- Test and implement NbS concepts in practice
- Supported with fundamental knowledge
- Translated to practical design guidelines
- Aimed at upscaling and mainstreaming

EcoShape
building with nature

How to design and implement Nature-Based Solutions (NBS)

- Introduction
- Building with Nature approach
  - Methodology to design and implement Nature-Based Solutions
- Case study: city at the river
- Background information
- Key messages

How to design and implement Nature-Based Solutions (NBS)

- Building with Nature approach

  Methodology to design and implement Nature-Based Solutions

  - Landscapes and concepts
  - Enablers
  - 5 step approach

Building with Nature: Landscapes and concepts

Sandy Coasts

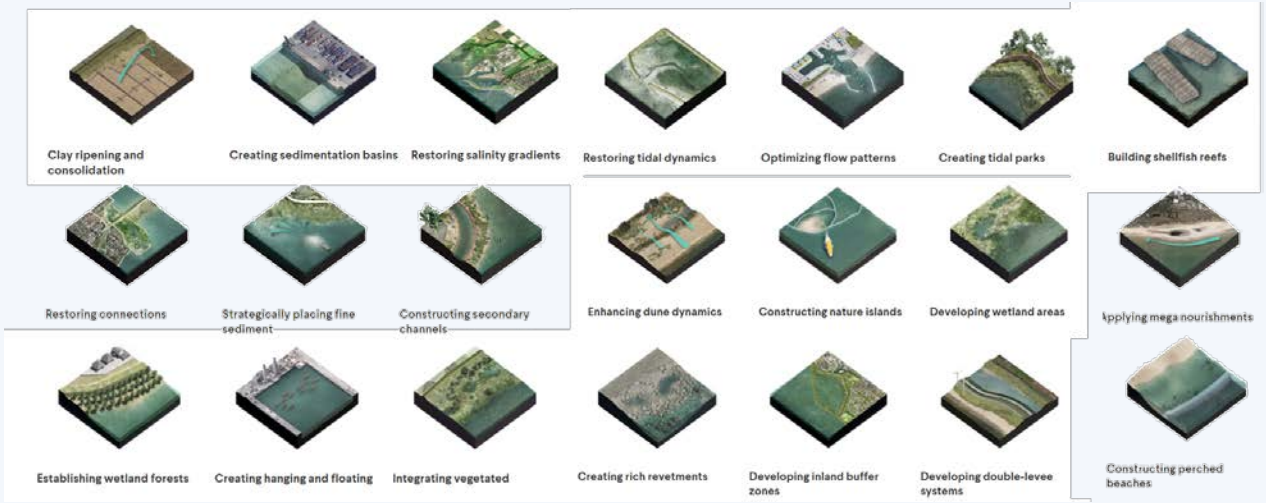
Muddy Coasts

Rivers & Estuaries

Cities

Lowland Lakes

Ports



Enablers for Building with Nature implementation

1. Technology and system knowledge
2. Multi-stakeholder approach
3. Adaptive management, maintenance and monitoring
4. Institutional embedding
5. Business case
6. Capacity building

BwN - 6 enablers

- Technology and system knowledge
  - Large-scale system analysis, comprehension of driving natural processes and natural dynamics.
  - Various Building with Nature instruments that suit different landscapes.
  - Building with Nature design approaches and assessment tools.

- Multi-stakeholder approach
  - Cooperation between stakeholders and comprehensive, multifunctional approaches.
  - Coalition building, co-creation and public participatory approaches to create shared ambitions.
  - Stakeholder assessment and engagement.

BwN - 6 enablers

- Adaptive management, maintenance and monitoring
  - Balancing initial efforts/investments (over-dimensioning) against adaptivity and resilience.
  - Making maintenance strategies an integral part of the development process.
  - Organisation and techniques for adaptive management and monitoring to deal with natural dynamics at various temporal and spatial scales.

- Institutional embedding
  - Fitting Building with Nature in the existing context, norms, and regulations.
  - Creating a policy environment that enables conservations laws and formal instruments to be addressed.
  - Connecting with international enabling policies, including the Paris Agreement, Sendai Framework, AICHI targets, CBD, Ramsar and UNCCD resolutions and SDGs.

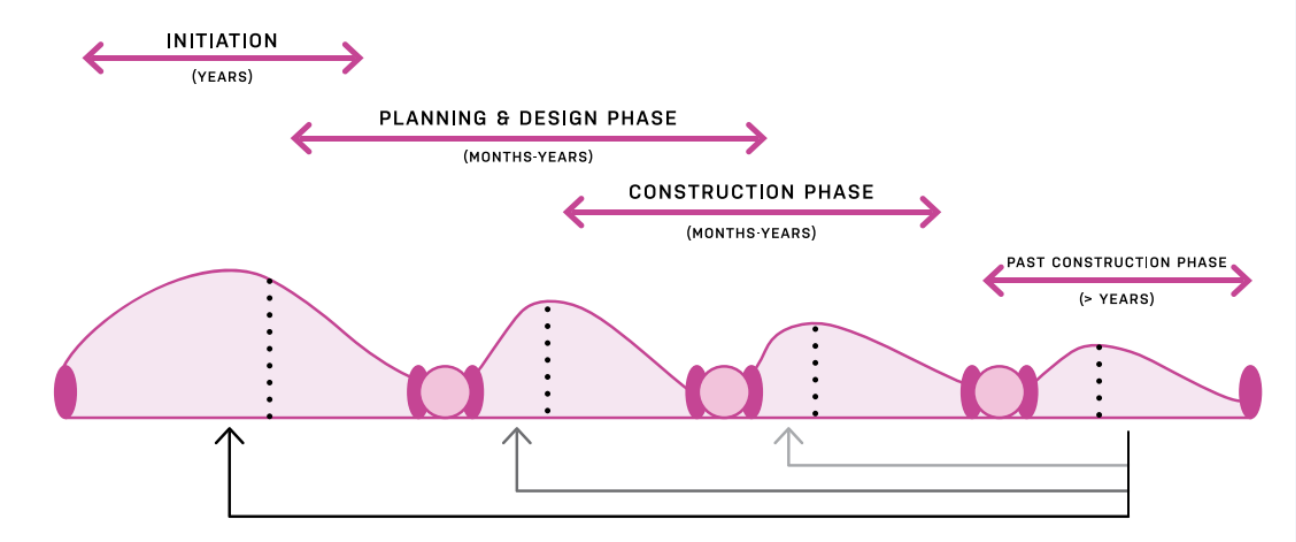
BwN - 6 enablers

- Business case
  - Defining an optimum business model by integrating conventional engineering and nature conservation expertise with financial knowledge.
  - Improving estimates of maintenance costs and the additional services and benefits (including coastal access, fish production, carbon sequestration).
  - Financing arrangement and pre-requisites (bankable value creation streams).

- Capacity building
  - Increasing awareness of the philosophy and possibilities of Building with Nature.
  - Involving the upcoming generation in Building with Nature through training and educational programmes.
  - Creating Building with Nature communities around your project.

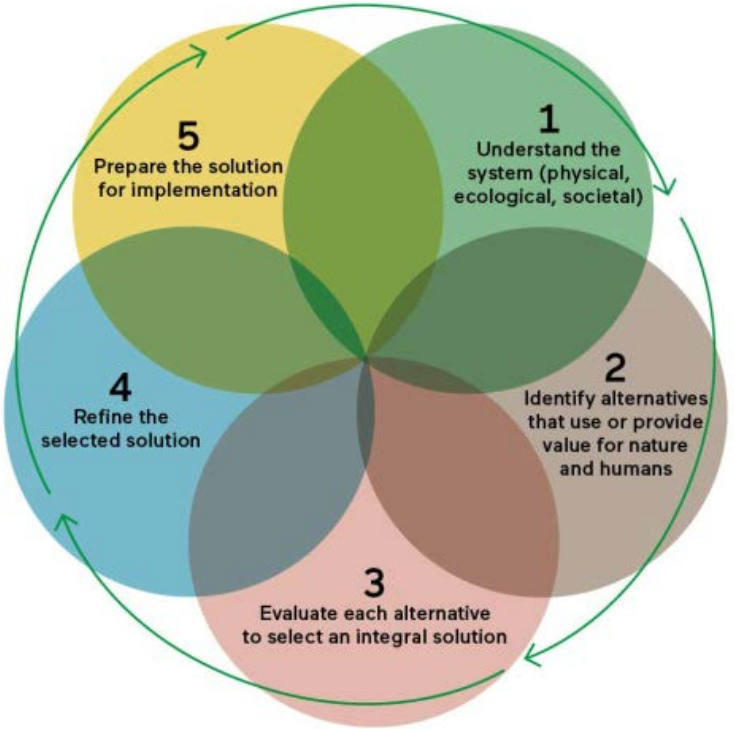
BwN – 4 project phases

1. Initiation
2. Planning and design
3. Construction
4. Past construction



BwN – 5 steps

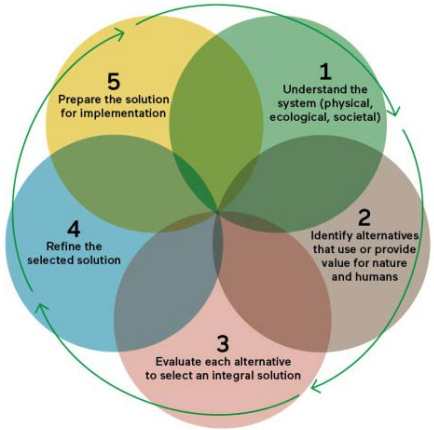
1. Understand the system
2. Identify alternatives
3. Evaluate each alternative
4. Refine the selected solution
5. Prepare the solution for next phase

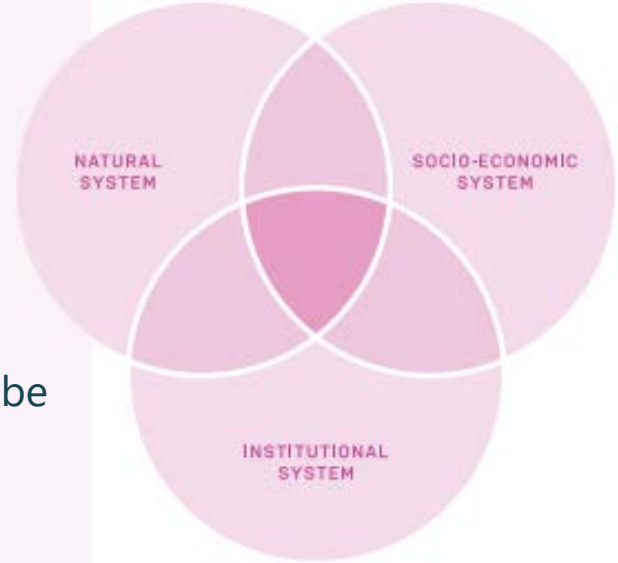


BwN – 1. Understand the system

- What are the problems
- Consider the system:
  - natural,
  - socio-economic
  - institutional system

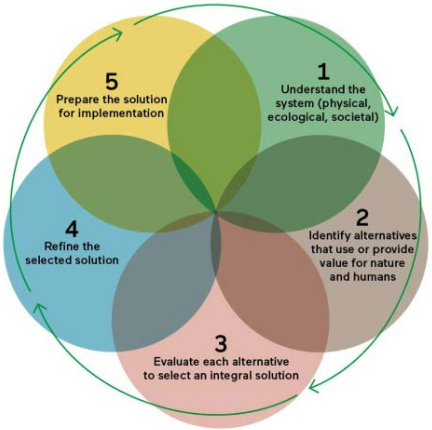
  at different scales
- Information about the system can be derived from various sources
- Think multi-functional





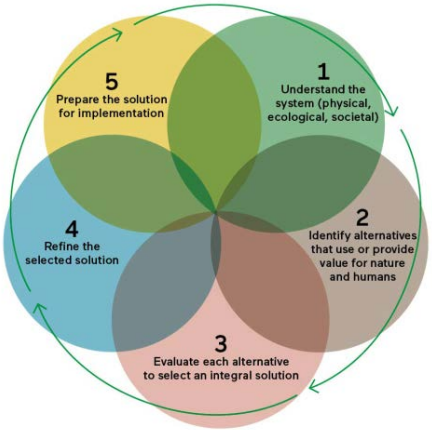
BwN – 2. Identify alternatives

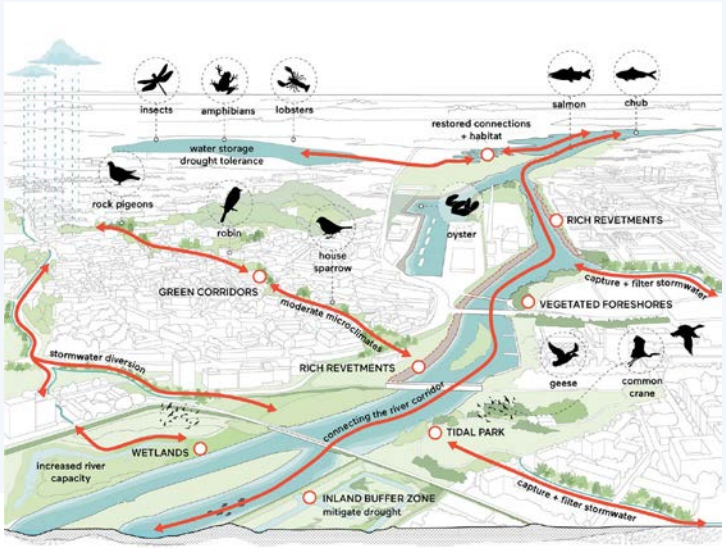
- Change your perspective
  - Supporting the ecosystem
  - Utilising functions of the ecosystem
- Think about transdisciplinary solutions from the start



BwN – 3. Evaluate each alternative

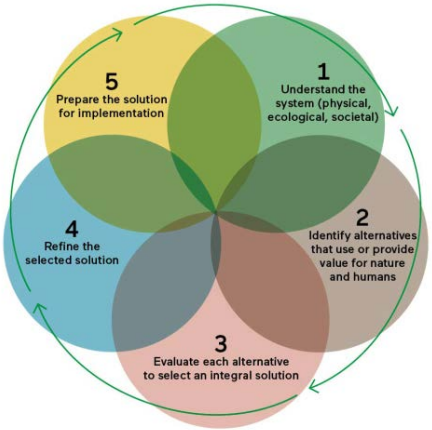
- Improve value without increasing construction cost
- Embrace creativity
- Identify and manage uncertainties
- Involve stakeholders in the evaluation and selection process
- Perform a (social) cost-benefit analysis

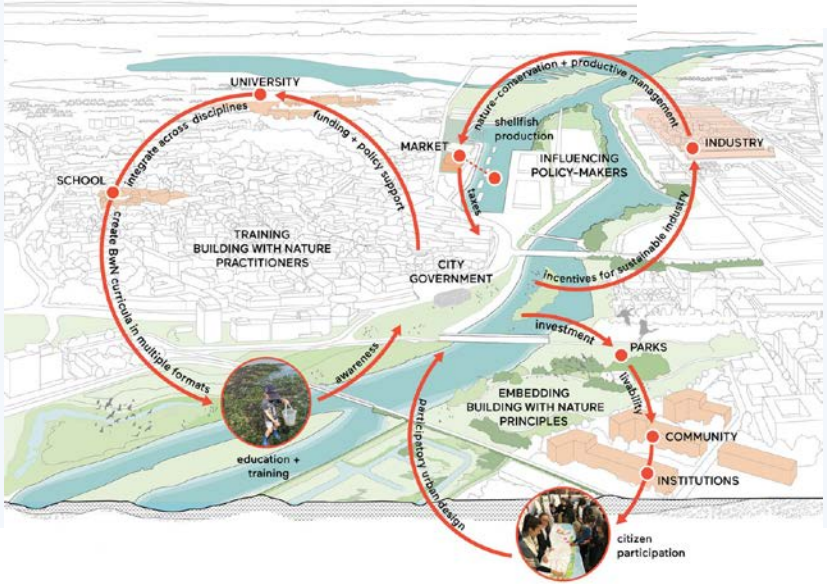




BwN – 4. Refine the selected solution

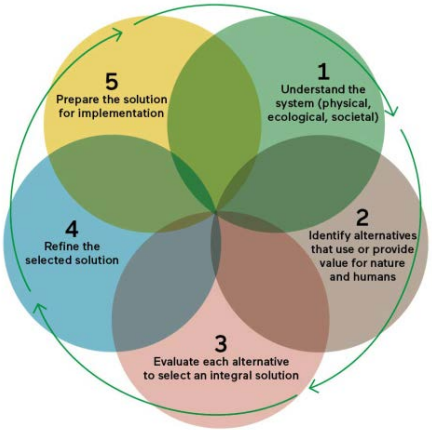
- Consider the conditions/restrictions of the project
- Improve your stakeholder network





BwN – 5. Prepare solution for next phase

- Translate solution to a technical design
- Translate solution to ‘request for proposals’ or contract
- Organise required funding
- Identify permit requirements
- Prepare risk analysis and contingency plans



How to design and implement Nature-Based Solutions (NBS)

- Introduction
- Building with Nature approach

  Methodology to design and implement Nature-Based Solutions
- Case study: city at the river
- Background information
- Key messages

Building with Nature in a city at the river

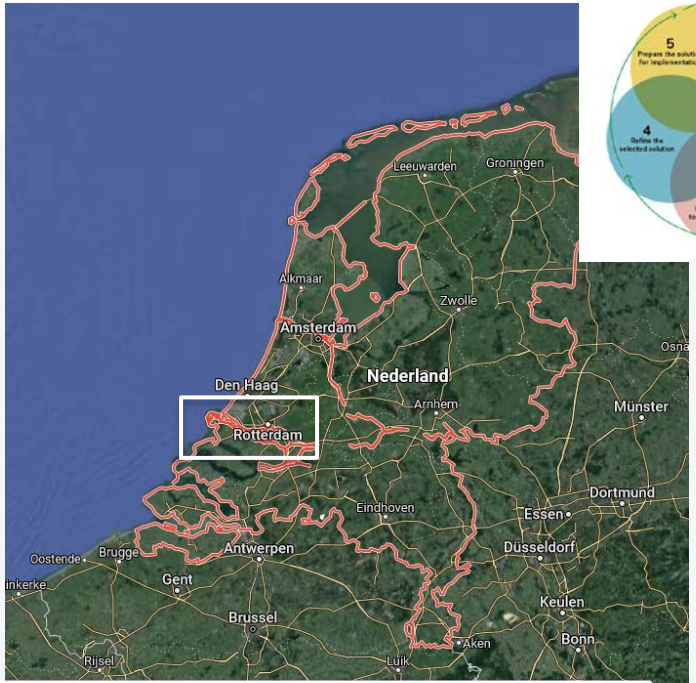
Rotterdam (the Netherlands)

- Flood proof public squares
- Green roofs and walls
- Wadis
- Tidal parks in the river
- Natural embankments

BwN – 1. Understand the system

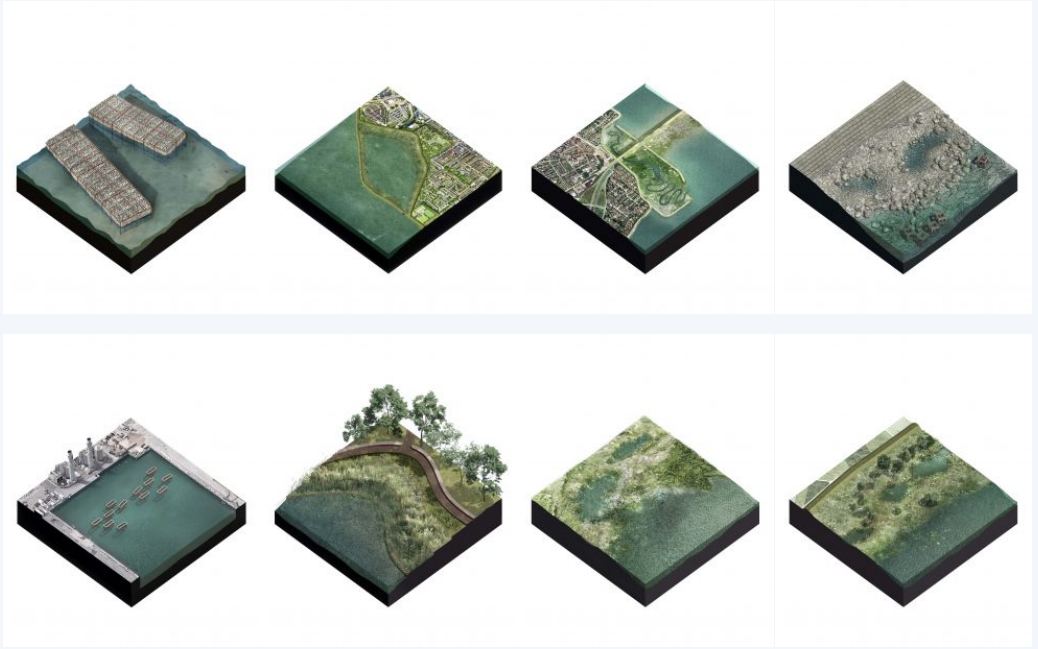
- What are the problems
  - Flooding, heat stress, attractiveness
- Consider the systems:
  - natural,
  - socio-economic
  - institutional system

  at different scales
- Information about the system can be derived from various sources
- Think multi-functional



BwN – 2. Identify alternatives

- Change your perspective
  - Supporting the ecosystem
  - Utilising functions of the ecosystem
- Think about transdisciplinary solutions from the start
  - Environment
  - Society
  - Economy
  - Institutional
  - Technical, financial



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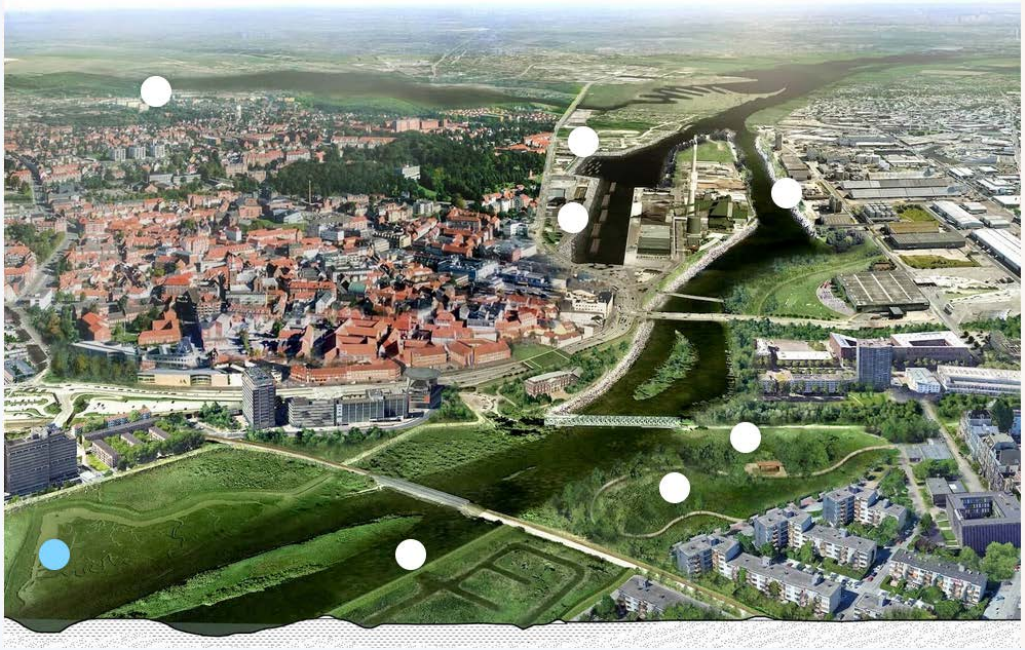

BwN – 4. Refine the selected solution

- Consider the conditions/restrictions of the project
- Improve your stakeholder network

BwN – 5. Prepare solution for next phase

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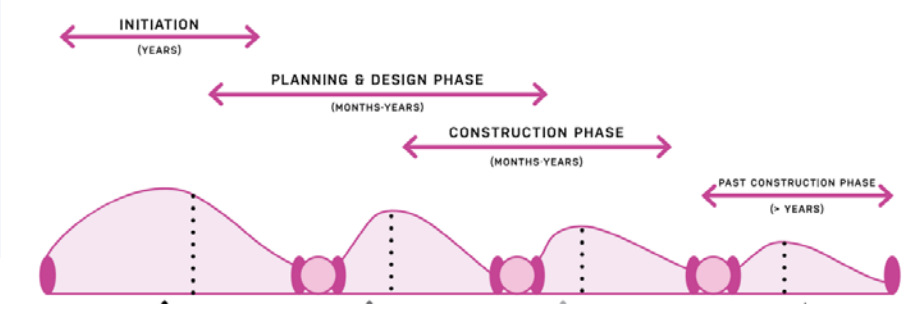

How to design and implement Nature-Based Solutions (NBS)

- Introduction
- Building with Nature approach

  Methodology to design and implement Nature-Based Solutions
- Case study: city at the river
- Background information
- Key messages

How to design and implement Nature-Based Solutions (NBS)

Background information:

- https://www.ecoshape.org/en/
  - https://www.ecoshape.org/en/landscapes/cities/
  - https://www.ecoshape.org/en/concepts/

  - https://www.ecoshape.org/en/the-building-with-nature-philosophy/
  - https://www.ecoshape.org/en/enablers/
  - https://www.ecoshape.org/en/the-building-with-nature-philosophy/five-basic-steps-for-generating-building-with-nature-designs/

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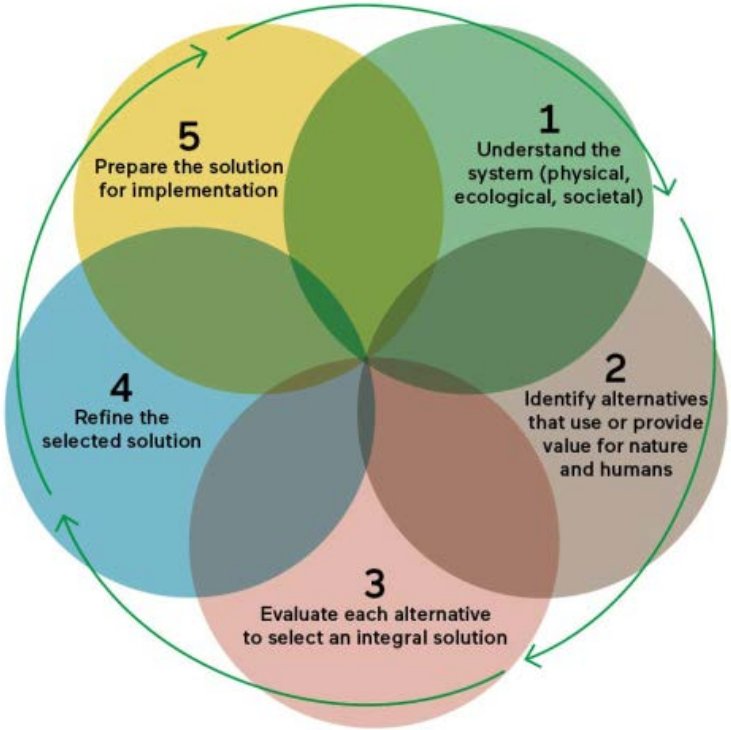
Enablers

1. Technology and system knowledge
2. Multi-stakeholder approach
3. Adaptive management, maintenance and monitoring
4. Institutional embedding
5. Business case
6. Capacity building

5 step approach

1. Understand the system
2. Identify alternatives
3. Evaluate each alternative
4. Refine the selected solution
5. Prepare the solution for next phase



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PROJECTS

Projects as of 31 December 2016

The Netherlands 3,085 projects
Africa, Europe and the Americas 279 projects
CIS countries 33 projects
Middle East 21 projects
South East Asia and Australia 102 projects

1 - 4 · 4 - 10 · 10 - 20 · 20 - 50 · 50 - 80 · 110 - 140 · > 3.000 projects

Witteveen+Bos projects
Witteveen+Bos offices (19)
Region classification

Room for the River

- national plan river basin approach
- extra discharge capacity to cope with extreme volumes of water without flooding
- 30 projects in approximately 10 year program
- Witteveen+Bos was involved in 12 projects (since 2006)
- Full service – from assessment and strategy to procurement and supervision

New channel and adaptation of flood plain

- 2008 – 2015 multi stage project :
  - Master planning – Field surveys – Technical Design
  - Environmental Impact Assessment – Permits
  - EC Contract and Procurement – Supervision
- Stakeholder Management – water based companies
- Managed and provided all services (excl. surveys)
- 3 km river bank
  - Industrial estate – docking facilities, infrastructure
- First project realised in Room for the River program