Business Models & Financing Strategies

D6.3 Deliverable

30/11/2018

Ernesta Mačiulytė,[1] *Margherita Cioffi*[2], *Francesca Zappia*[2], *Elenia Duce*[2], *Andrea Ferrari*[2], *Matheus Fernando Kelson Batinga de Mendoca*[1], *Gianni Loriga*[2], *Petr Suška*[1], *Brenda Lorena Vaccari Paz*[1], *Donato Zangani*[2], *Pieter Hein Bult*[1]

[1] *Fraunhofer Institute for Industrial Engineering (IAO), Nobelstraße 12, 70569 Stuttgart, Germany*
[2] *RINA Consulting S.p.A., Via Renata Bianchi, 38, 16152 Genoa, Italy*

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052

Topic: ***SCC-2-2016-2017: Smart Cities and Communities Nature based solutions***

Dissemination level		
PU	Public	x
CO	Confidential, only for members of the consortium (including the Commission Services)	

Deliverable administration					
No & name	**D6.3 Business Models & Financing Strategies**				
Status		**Due**	M18	**Date**	30-11-2018
Author(s)					
Description of the related task and the deliverable. Extract from DoA	**T6.3 Development of Financing Strategies for NBS (FHG, DAPP, EIN, GEN, TRE) M1-60** T6.3 will develop holistic strategies for financing NBS that will include both business models for implemented NBS as well as alternative financing strategies. These financing strategies will complement the NBS Technical Handbook (WP5) and be delivered in a separate handbook supporting NBS implementation along with governance models, the Replication Framework, and Roadmapping Strategy. Results of T6.3.1 (replicable business models) will provide the basis for development of a holistic NBS Value Model (T6.3.2). This task outputs D6.3, D6.4 and contributes D6.6 and D6.8. In addition, within this task a co-operation with other SCC02 projects was established in order to focus on the development and comparison of financial strategies across the SCC02 consortia. Also, the task will provide regular information of the progress, outputs and potential alignment of activities to task T1.7. FHG leads this task with assistance from DAPP and input from EIN, GEN and TRE.				
Participants	Fraunhofer Institute for Industrial Engineering, Rina, Gemeente Eindhoven (EIN), Comune di Genova (GEN), Tampereen Kaupunki (TRE)				
Comments					

V	Date	Authors	Description
1	19.10.2018	RINA	Business Models of NBS
2	15.11.2018	FHG	Financing Strategies for NBS
3	22.05.2019	FHG, RINA	Revised version (intermediate)
4	31.07.2019	FHG, RINA	Revised version (final)

About UNaLab

UNaLab will develop, via co-creation with stakeholders and implementation of 'living lab' demonstration areas, a robust evidence base and European framework of innovative, replicable, and locally-attuned nature-based solutions to enhance the climate and water resilience of cities. UNaLab focuses on urban ecological water management, accompanied with greening measures and innovative and inclusive urban design. The UNaLab partners aim to develop smarter, more inclusive, more resilient and more sustainable local societies through nature based innovation jointly created with and for stakeholders and citizens. UNaLab's 3 front runner cities: Tampere, Eindhoven and Genova, have a track record in smart and citizen driven solutions for sustainable development. They support 7 follower cities: Stavanger, Prague, Castellon, Cannes, Basaksehir, Hong Kong and Buenos Aires plus share experiences with observers as City of Guangzhou and the Brazilian network of Smart Cities. Therefore UNaLab results will impact on different urban socio-economic realities, with diversity in size, challenges and climate conditions. In order to create an EU reference demonstration and go-to-market environment for NBS, UNaLab will use and further develop the ENoLL Urban Living Lab model, and the European Awareness Scenario Workshop method for the co-creation of solutions, and the roadmap approach, in this way achieving an innovative NBS toolbox.

Partners

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

EXECUTIVE SUMMARY

This report provides city planners with examples of business models for selected NBS, as well as potential financing strategies that could support NBS implementation and operation efforts. As city interventions are always context-dependent, there are no one-size-fits-all solutions to be offered. Instead, this report aims at providing policy makers with the key components of the NBS business models, following a business model canvas approach. Based on these business models, the report introduces a mapping of financing mechanism alternatives for cities interested in working with NBS. This report analyses how and within which contexts the reviewed financing strategies are expected to work best with NBS technologies. The information presented is based on the NBS interventions foreseen in the UNaLab Front-runner Cities as well as additional examples and insights collected from other Horizon 2020 projects and NBS databases.

1. INTRODUCTION

Urban infrastructure planning and management are central elements defining the identities of cities, with implications on how citizens live and how benefits and risks are distributed socially and spatially. With the emergence of environmental awareness in the second half of the 20th century and of sustainability as a cross-cutting concept in all public spheres, urban planning also had to incorporate new sets of challenges to meet the expectations of political actors, financial institutions and citizens concerned with sustainability. This is, however, a dynamic and constantly evolving process, as the environmental scientific knowledge, concepts, technologies and social expectations evolve. Likewise, the issue of how to finance sustainable urban infrastructure – the main focus of this report – also had to adapt to the societal, technical and scientific transformations propelled by the emergence of the concept of environmental sustainability within the realm of urban planning.

The development of the concept of Nature-based Solutions (NBS) in cities demands new insights into how to address its financial dimension. This demand reflects the acknowledgement that smart and innovative financing strategies need to take into consideration the specific institutional, technical, economic and normative contexts where they are applied, and that these contexts need to be adequately understood by the parties involved, be those financial institutions, municipal governments, private companies or civil society.

A traditional approach to financing urban infrastructure projects can be generally described as one in which the city is solely responsible for planning, designing, financing, building, maintaining and operating the project. In this scenario, finance comes either from the public budget (through the collection of taxes, fees, levies etc.) or external sources, in the form of loans or grants by public and private financial institutions, public funds and multilateral agencies. This model has its advantages – these types of projects are in general routinely performed by cities and often predictable in terms of risks. However, it also implies that the costs, benefits and risks involved are often borne entirely by the city, requiring increasing levels of budgetary liquidity and qualified personnel to maintain and oversee both financial flows and technical operations.

The alternative to this approach is to involve other actors in the process, notably the private sector, for financing or executing one or more activities related to the project. This statement, however, is still broad and includes several different ways of involving private actors, ranging from simple procurement to complex arrangements involving several different financial sources and operational entities in long-term contracts. Consequently, the degree of complexity and

innovation of the financing mechanisms that could encourage private sector investments to NBS varies substantially.

In this context, this report aims as exploring the relevant components and limitation of NBS business models and the subsequent financing strategies that could be employed by cities to promote NBS implementation and mainstreaming.

1.1 Methodology

All the information used to characterise the business models of NBS implemented in Front-runner Cities was gathered by their direct contributions from the Front-runner Cities. The examples provided for each typology of NBS were gathered from other NBS projects and from the EU repository Oppla, the open platform dedicated to the collection of NBS. The representatives of Eindhoven, Tampere and Genoa were asked to select 2-4 on-going/planned NBS projects and fill out the Business Model Canvas template for each of the interventions. The feedback from the cities was gathered during the period of September 2018 – June 2019.

The subsequent sections of this report that discuss the financing strategies available to the cities are based on the data collected through semi-structured expert interviews and literature review of the academic and grey literature.

The analysis of literature on financial mechanisms that could be used for financing NBS, green and blue infrastructure, as well as climate change adaptation and mitigation projects was performed. ~30 financial tools were identified (see *Annex 5.1 List of the identified financial mechanisms*). This overview served as a basis for subsequent descriptions and categorisation of the financial mechanisms into five groups, which are described in section *3.1 Alternative financing strategies for NBS* of this report. The data on the basic definitions, associated risks and potential advantages and disadvantages for the five identified groups were gathered. And is presented in this report. In addition, two semi-structured expert interviews have been conducted to gather the insights on NBS financing aspects from other Horizon 2020 NBS demonstration projects.

Finally, to ensure a comprehensive analysis of the NBS business models and financing strategies as well as promote continuity in the UNaLab project, this report has consulted the data collected for the UNaLab *D.5.3 Municipal Governance Recommendations* and *D6.2 UNaLab Municipal Governance Guidelines*.

1.2 Relation to other UNaLab activities

The development of business models and financing strategies for NBS is a continuous process throughout the lifetime of UNaLab. This report is only the first steps towards a comprehensive replication assessment of NBS implemented by Front-runner Cities, which will ultimately feed into the UNaLab deliverable *D6.8 Handbook to Support NBS Implementation* expected in May 2022.

From a business model analysis perspective, a quantitative cost-benefit analysis will be provided when further details on NBS implementation and maintenance costs as well as first monitoring data is available in the Front-runner Cities (expected around November 2020).

This information will be used for a comprehensive replication assessment of the implemented NBS types in other contexts and/or cities, including the Follower Cities. This is an ongoing activity under *Task 6.2 NBS Value Chain Analysis & Evaluation of Replication & Upscaling Potential*. Initial replication assessment was qualitatively performed during the Business Model

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Workshop organised in Basaksehir (Istanbul, Turkey), the 29th of November 2018, focusing only on one NBS for each Front-runner Cities. The results were shared in the UNaLab Buddy System web space.

2. UNALAB BUSINESS MODELS

In this chapter, business models for selected NBS categories reported in the *D5.1 NSB Technical Handbook* are here described. **This chapter focuses on the NBS categories for which the Front-runner Cities** – Genoa, Eindhoven and Tampere **– identified specific NBS to be implemented during the project**. Such NBS exhibited suitable technical performance and high replication potential, based on the Canvas methodological approach described in *Annex 5.2*.

The data for the business models of NBS selected by Front-runner Cities was gathered during the first exploitation workshop held in Genoa on 22nd of November 2017 and by means of ad-hoc surveys involving Front-runner Cities. **All the information provided in this chapter, when not explicitly declared, derive from the individual experiences of each Front-runner City**.

In order to summarize the main components of the underlying NBS business models, for the selected NBS categories, examples of NBS implemented in cities other than those participating in the UNaLab project were also studied. Case studies have been collected from other NBS projects and from the EU repository Oppla, the open platform dedicated to the collection of NBS.

Based on such analysis, **a summary description of the NBS business model was provided for each type of investigated NBS**, reporting the following information: main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits. Costs are reported according to ranges estimated by Front-runner Cities and/or reported in the literature and they may vary considerably by region and local conditions in which NBS are implemented. The identified financing strategies and options are described in details in *3.Financing Strategies for NBS*.

In addition, for each of the NBS categories, both **case studies** implemented in cities beyond UNaLab project, as well as business models elaborated by UNaLab Front-runner cities are illustrated.

The Nature-based Solutions Business Model Canvas was used in the following sections to study the UNaLab NBS, because is an easy-to-use tool that helps capture the business model of NBS in a visual format. It is a tool that was already used and tested in the past in other NBS projects to support the plan of NBS implementation. In particular, the NBS Business Model Canvas was used as a tool to support the initial stages of planning the implementation of NBS in the cities engaged in the European "Connecting Nature" project.

In particular, the Business Model Canvas used for NBS projects helps:

- **To communicate**. NBS is a relatively new concept difficult to explain to people who do not know it. For this reason, NBS Business Model Canvas provides a simple way of telling others what you want to do and why, who needs to be involved and how you are going to make it happen. The NBS Business Model Canvas uses language which is widely understood by people from many different backgrounds.
- **To plan** the start of an NBS project implementation. It helps to consider all the basic building blocks of building a successful long-term sustainable project.
- **To identify new partners**. By considering the value that NBS may offer to different groups of people, the NBS Business Model Canvas helps to identify potential new

partners or beneficiaries that may be interested in getting involved in the planning, implementation or ongoing maintenance of NBS.

- **To explore new sources of finance**. Combining reflections on the value of NBS with the identification of new partners may help to identify potential sources of initial NBS financing or partners who could help with financing ongoing costs or contributing to cost reduction.
- **To broad the value proposition**. The NBS Business Model Canvas considers environmental, social and economic values, leading to the identification of new stakeholders and alternative ways of capturing value. This may also lead to the identification of new sources of financing.

Table 2.1 shows the NBS categories selected from the UNaLab *NBS Technical Handbook* and analysed in the present report (first column), the related NBS solutions implemented by the Front-runner Cities (second column) and similar examples implemented in other projects (third column).

Table 2.1: Correspondence between the selected NBS and the NBS categories of the UNaLab Technical Handbook

NBS Category	Examples in UNaLab FRCs	Other Examples
Permeable Surfaces and Green Urban Areas	Permeable pavements in Genoa	• Research conducted by the University of California Davis (Terhell, Cai, Chiu, & Murphy, 2016) • Urban regeneration and adaptation to climate change in Szeged (Oppla, n.d.)
	Permeable Surfaces and Green Urban Areas in Clausplein (Eindhoven)	
	Urban Gardens with Small-Scale NBS in Tampere	
River Restoration	Re-Establishment of Watercourses (Daylighting) in Victoriapark (Eindhoven)	• The urban river restoration in Lodz: a sustainable strategy for storm water management (Climate-ADAPT, 2014) • Isar-Plan in Germany – Water management plan and restoration of the Isar River, Munich (Climate-ADAPT, 2015b)
Green Roofs and vertical greening	Green Roofs/Green Building Façades in Eindhoven	• Mitigation and adaptation measures in Basel (Climate-ADAPT, 2015a) • Green Living Room in Ludwigsburg (Oppla, n.d.)
	Green Roofs in Tampere	
	Vegetated Gabions in Genoa	
	Infiltration Basins in Genoa	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Water sensitive urban design measures	Storm Water System (Bio Filter, Retentions Basins, Alluvial Meadow) in Vuores (Tampere)	• The Queen Mary's Walk, Llanelli (Susdrain, n.d.) • Houndsden Road Rain Gardens, London (Susdrain, n.d.)

2.1 Permeable Surfaces and Green Urban Areas – Business Model examples

2.1.1 Permeable pavements

Permeable pavement is a porous urban surface composed of open pore pavers, concrete, or asphalt with an underlying stone reservoir. Permeable pavement catches precipitation and surface runoff, storing it in the reservoir while slowly allowing it to infiltrate into the soil below or discharge via a drain tile. The most common uses of permeable pavement are parking lots, low-traffic roads, sidewalks, and driveways. They are commonly installed on car parks, residential streets or sidewalks.

There is a variety of different permeable surfaces that is available for a range of applications. For example, porous asphalt is the cheapest available surface material but its application is limited due to low weight bearing capacity (Selbig, n.d.).This surface would be best for bike paths or walking paths that do not have car traffic. For high traffic roads, permeable pavers or pervious concrete would be an ideal surface.

Figure 2.1: Pavement types - permeable pavers, permeable concrete and permeable asphalt

Source: USGS website (public domain)

Permeable pavements help re-establishing a more natural hydrologic balance and reducing runoff volume by trapping and slowly releasing precipitation into the ground. This same process also reduces the peak rates of discharge by preventing large, fast pulses of precipitation through the storm water system. In addition, permeable pavement can reduce the concentration of some pollutants. Finally, permeable pavements can also cool down the temperature of urban runoff, reducing the stress and impact on the stream or lake environment.

The following *Table 2.2* resumes main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits of permeable pavements, considering the desk research, the analysis of the NBS implemented in Front-runner Cities and information provided in the *D5.1 NSB Technical Handbook.*

Table 2.2: Features, value proposition, conditions for implementation, stakeholders, costs, financing options and limits of permeable pavements

Features

- Permeable pavers consist of concrete bricks with gaps/funnels between the single bricks
- A variety of single rocks create the permeable paver surface
- Gaps and funnels between bricks are commonly filled with stone and sand or grass
- Concrete bricks are located on a stone layer
- After the storm water event, water trickles/infiltrates through gaps/funnels between bricks
- Water is temporarily stored in the underlying stone layer and infiltrates into the soil or to an additional drainage layer conveys water into the sewage system (subsurface drain)
- Water uptake by plants (if plants established in funnels between concrete bricks)
- Application area: parking lots, sidewalks, bike paths, driveways, street, etc.
- Function:
  - reduced surface/storm water runoff
  - water filtering → reduced amount of pollutants
  - delayed runoff

Value proposition/Benefits

- Water quality protection and filtering
- Storm water management
- Reduced surface runoff
- Controlled infiltration
- Temporary water storage
- Environmental protection of the area by reducing the hydrological risk with an associated decrease of economic and social costs.
- Social inclusiveness and landscape perception
- Reduction of local temperature, pollution and urban heat island effect
- Increased biodiversity

Conditions for Implementation

- Implementation on new or existing building sites
- Prior analysis of the soil is necessary

Limitations/Barriers

- Limited load on the paved area
- Installation costs

Stakeholders/Beneficiaries

- Inhabitants and citizens will benefit on the creation of new open spaces and green infrastructure
- A municipality can finance the renovation of the area (different departments can be involved e.g. urban green, mobility, water board, etc.)
- City users: people that do not live in the city but come regularly in the city for work or to use other services or amenities

Costs

Permeable pavements require more initial costs than for normal asphalt installation. The high initial cost is due to the design and infrastructure necessary to let surface water permeate to the underlying soil. Their high installation cost leads to much less maintenance required.

- Manufacturing costs ≈200.000-300.000 € depending on the scale of the plan
- Implementation costs ≈ 80-100 €/m2
- Maintenance costs ≈ 0-2 €/m2 year

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052

Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

• Local businesses (e.g. shops, real estate agencies, professional associations etc.)	

Financing options

- Innovative municipal financing approaches
  - Municipal investment: municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance
  - Accessing external funding sources: for example regional, national and EU and/or other funds can be an important source of NBS financing
- Public-Private partnerships
  - Mobilising investment from municipal enterprises/utilities: for example Municipalities and municipal companies might want to co-invest in interventions that support achieving their strategic and political goals
  - Institutionalised PPPs in terms of citizen associations: for example shops around the area could be involved in maintenance activities
- Mandatory Requirements and Tax Initiatives
  - User fees: for example contractual fees, such as fees incurred for using a public park as a venue for an event
- Incentive programmes
  - Crowd-funding/sponsorship: for example private sponsors can be involved in maintenance activities

2.1.2 Case study of permeable pavements beyond UNaLab

According to research conducted by the University of California Davis (Terhell et al., 2016), permeable pavements are a valuable alternative to common asphalt, even if they have different associated costs. In fact, they require more initial costs (money and labour) than required for normal asphalt installation. The high initial cost associated with permeable surfaces is due to the design and infrastructure necessary to properly let surface water permeate to the underlying soil. A large amount of excavation is necessary to install the underlying layers of aggregate material, forming layers underneath the permeable surface able to offer assistance in the process of water filtration. The high installation cost of permeable pavements leads to much less maintenance required over the life of the surface in relation to that of regular asphalt. The only regular upkeep needed for permeable pavements is vacuuming, in order to maintain high permeability.

2.1.3 The business model of permeable pavements in Genoa

Permeable pavements are mainly pedestrian and vehicle accessible areas covered in resin bound gravel, as well as in water bound surface with an eco-compatible binder.

Their implementation is planned to be located in the centre of Lagaccio District and, in particular, in the area of the Gavoglio Barracks, for which the following actions are expected:

- Demolition of over 43 000 m^3 of old industrial buildings, land reclamation and debris recovery.
- Preparation of some the ground (including green spaces) for sport and recreational activities.
- Pedestrian and driveway paths and public spaces made of permeable materials to promote the ground absorption of meteoric water.

Generally, other types of permeable materials will be deployed depending on the intended use of the surfaces, such as natural grass and grass grids for meadows, mulching for shrubs areas, sand for kid's playgrounds, natural stone paving for the refurbishment of heritage-protected areas.

Value Proposition

The city of Genoa is hit by frequent flooding, which resulted in significant destruction in the past, primarily due to intense rainfall on a highly-urbanised landscape (Brandolini, Cevasco, Firpo, Robbiano, & Sacchini, 2012). The city faces numerous environmental challenges relating to extreme weather conditions, water management issues, heat stress, and water and air pollution.

Permeable pavements allow increasing the **environmental protection of the area by reducing the hydrological risk** and by increasing the geological consolidation of the slopes. In fact, the permeable pavements are able to increase the natural permeability of the soil: they allow reducing the management of surface runoff by direct infiltration into the ground or, considering the limited permeability of substrates in the area, by partial detention and further inlet into the drainage infrastructure.

Moreover, with the selected NBS, the municipality addresses Genoa's needs of **improving the local mobility** and increasing the district and **landscape perception**: the solutions will enable the creation of new connections (green areas, walkways and driveways) between the two sides of the area, thus improving the relationship between the valley slopes and the sea horizon.

The municipality is expected to have an impact on **social inclusiveness in a socially deprived area**, by the creation of an urban park with outdoor sports facilities and green areas.

Furthermore, the implementation of permeable pavements will also allow fulfilling other specific needs of the neighbourhood such as the **reduction of local temperature, pollution and urban heat island effect**, with the result of a better quality of life for the inhabitants.

Such elements, together with **increased biodiversity**, will allow the **creation of new attractive pole for investments, real estate and commercial activities**. The reduced hydrogeological risk is expected to lead to **decreased flooding occurrence and/or damage caused by flooding, with an associated decrease of economic and social costs**, including water treatment costs.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Inhabitants and citizens: people that live in the city and, in particular, in the Lagaccio district will benefit on the creation of new open spaces and of the realisation of green infrastructure in a strongly urbanised context.
- Municipality: the Municipality of Genoa owns the building and finances the renovation of the area.
- City users: people that do not live in the city but come regularly in the city for work or to use other services or amenities could benefit from the requalification of the area.
- Local businesses (e.g. shops, real estate agencies, professional associations etc.) could increase their earnings due to the requalification of the area and improvement of the quality of life. Currently, the area is closed to the public: its requalification and the availability of recreation opportunities will attract more people in the surroundings, potentially leading to increased commercial opportunities.

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Financing models

According to a first estimation coming from the Municipality of Genoa, all interventions needed for the realisation of the selected NBS foresee public funds. However, private sponsors could be involved during the progress of the project, due to the innovativeness of the selected NBS. In particular, shops around the area could sponsor maintenance activities, contributing directly to the requalification of the district. They could be helped also by citizens voluntary associations engaged in the requalification of socially deprived areas. Furthermore, the municipality may pay a small fee for the maintenance of the selected NBS to building tenants.

Actors involved in the implementation and maintenance of permeable pavements

The successful integration of the selected NBS in Genoa's master plan was made possible by means of active involvement of a variety of stakeholders. In addition, the following actors will be involved in NBS implementation and maintenance:

- Municipality of Genoa
- Tenants of building nearby the green parks (e.g. B&B, social services, student rooms)
- Liguria Region
- Water utility providers
- Citizens and local/voluntary associations
- University of Genoa
- Business associations (engineers, architects, biologists, urban ecologists and planners)

Key activities

The following *Table 2.3* identifies the key activities needed to deliver the proposition of the permeable pavements project.

Table 2.3: Key activities foreseen for the implementation of the permeable pavements

Key activities	Description
R&D	Research in the design of the permeable pavement
Demolition	Demolition of buildings and street coverages
Hydraulic survey	Specific analysis on the ground water table, ground water fluctuations, permeability analysis of the soil
Frequent maintenance	Maintenance of the surface that includes periodic cleaning of filters and rooms
Technologies selection	Selection of suitable technologies for permeable pavements
Implementation	The realisation of permeable pavements in the area of the Gavoglio Barracks

Key resources

The following *Table 2.4* identifies the key resources needed to fulfil the proposition of the project.

Table 2.4: Key resources for permeable pavements

Key resources	Needed to/for…
Planners	Design of the area surfaces
Building installers / Construction companies	Realise the designed works

Government/Municipality	Realise the master plan and the surveys
Money and funds (EU, Municipality)	Design, implement and maintain the NBS
Marketing and advertising materials	UNaLab dissemination and communication
Privates	Maintain the re-qualified and renovated area

The planned works for the implementation of permeable pavements in the Gavoglio Barracks area do not include any particular technology. Their implementation is limited to ordinary replacements of the actual pavements with more permeable materials and green areas. Only generic and common technologies will be applied.

Cost structure

This section collects the preliminary information about the main economic, social and environmental costs during the implementation of permeable pavements in the renovation works of the area.

Costs needed for the construction and maintenance of permeable pavements in the city of Genoa are currently under evaluation (the project is on-going). However, all costs reported in *Table 2.5* were estimated by the Municipality of Genoa, including labour cost.

Table 2.5: Cost for the permeable pavements

Type of costs	Cost for implementation	
	Resin bound gravel	Eco compatible binder
Manufacturing	350.000 €	60.000 €
Implementation	118 €/m2	60 €/m2
Maintenance	0 €/m2 year	1,5 €/m2 year

There are no expected costs regarding social and environmental aspects.

2.1.4 Green urban areas – residential parks, green corridors and other similar solutions

Green urban areas correspond to spaces with vegetation within or partly embraced by urban fabric. This class is assigned for urban greenery, which usually has recreational or ornamental character and is usually accessible for the public. Green urban areas aim at imparting several positive effects on urban ecosystems. Some main benefits are the provision of habitats for urban wildlife, regulation of air temperature, pollution control, shading, CO2 absorption, and human recreation.

The following *Table 2.6* resumes main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits of green urban areas, considering the desk research, the analysis of the NBS implemented in Front-runner Cities and information provided in the *D5.1 NSB Technical Handbook*.

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Table 2.6: Features, value proposition, conditions for implementation, stakeholders, costs, financing options and limits of green urban areas

Features
• Green areas, such as line trees and boulevards, have multiple effects on the local micro-climate conditions, absorb particular matter and provide shade for people as well as for buildings. One of the main positive effects for the human well-being in periods with high temperatures is the air cooling effect and the mitigation of urban heat stress. • Residential Parks are part of the Green Infrastructure (GI) of cities and serve the residential areas as the nearest main entry point for nature based recreation. Larger spatial elements of GI are district parks that often deliver more functions and combine various uses (e.g. sports fields). Smaller green spaces are often playgrounds or connecting green strips of land. • Areas of derelict infrastructure, e.g. railway lines, that are transformed into linear parks play an important role in urban green infrastructure networks and help to re-nature cities. Also regeneration along waterways and rivers often results in linear interconnecting parks.
Value proposition/Benefits
• Microclimate regulation/Habitat provision • Aesthetics/recreation • Rainwater regulation (delayed runoff) • Meeting places • Public spaces for heat reduction • Great potential for creating interconnected systems • Connectivity, biodiversity and ecosystem services • Improved air quality with higher CO2 absorption with a subsequent better quality of life • Reduced vehicle use decreasing greenhouse gas emissions • Reduced risk of flooding • Water storage capacity • Improved soil and water quality
Conditions for Implementation
• Local circumstances (e.g. topography, route characteristics, surrounding land use, and underground uses) need to be considered • The soil and subsurface should generally be suitable for the establishment of green areas and may need to be replaced by standard soils if necessary • New urban development areas provide the opportunity to locate residential parks at the most suitable location maximising the effects on urban climate. In order to have a maximised impact on urban climate the spatially equal distribution of parks is important. • Abandoned traffic infrastructure may be the most convenient way to establish linear parks and green corridors.
Limitations/Barriers
• The allergenic potential of pollen and BVOC emissions • Reduced airflow → Higher pollution in street canyon • Accessibility • Green corridors may need a high level of maintenance (e.g. bridges)
Stakeholders/Beneficiaries | **Costs**

• Local residents that express their opinions during forums held at the planning and implementation stages • A municipality can finance the renovation of the area • Offices: employees may benefit from the access to public green spaces improving their quality of life • Local businesses (e.g. shops, real estate agencies, professional associations etc.) will enhance their attractiveness and visibility • City water management (Water Board) monitors the quality of the water surface and it manages water levels in the areas where people live and work. Furthermore, it prevents floods in rural areas. The selected NBS will improve the water management system. • City users (e.g. employees and students): people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit of the requalification of the area • Green builders, maintenance and planning companies could obtain business opportunities planning, building and maintain the newly renovated area • Housing estates that during planning procedures participate in debates	• Planning costs ≈ 3000-5000 € depending on the scale of the plan • Implementation costs ≈ 1-10 €/m2 • Maintenance costs ≈ 0-10 €/m2 year

Financing options

- Innovative municipal financing approaches
  - Municipal investment: municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance. For example municipal green funds (e.g. Groenfonds in Eindhoven connected to the regulation for the compensation of green space)
  - Accessing external funding sources: for example regional, national and EU and/or other funds can be an important source of NBS financing
- Public-Private partnerships
  - Institutionalised PPPs in terms of citizen associations: for example housing companies and other communities can share the costs incurred for projects in public spaces
  - Business Improvement District (BID): BID implies financing and managing improvements to commercial and industrial environments based on the consent by a majority of businesses who accept an additional levy

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

  - Partnerships encouraged by external funding programmes (e.g. EU funding)
  - Contractual PPPs: standard contracts with the private sector for green space maintenance and operation

- Mandatory Requirements and Tax Initiatives
  - Private sector financing: private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems.
  - Land value & value-capture taxation: for example inhabitants and property owners pay taxes to allow a municipality to reach its objectives (e.g. in Eindhoven, if a building company needs to pave in green space, they have to make a deposit into the Groenfonds, fund dedicated to urban green measurements).

- Incentive programmes
  - Private sector financing: private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems
  - Partnership with private enterprises to obtain funds to co-finance projects: for example innovation vouchers enable existing housing companies and other communities to co-design and co-implement the NBS selected
  - Parks Trust: usually is a self-financing entity which relies on a number of different income sources, but always acts in the service of the public.

2.1.5 Case study of green urban areas beyond UNaLab

According to the Oppla repository of NBS, there are many examples of greening interventions implemented in EU cities and some of them will be reported below.

One of them refers to the NBS implemented in Szeged (Hungary) for urban regeneration and adaptation to climate change (Oppla, n.d.). The NBS concept aims to improve the quality of green areas and to restore natural habitats and ecological corridors for social and recreational purposes and to mitigate the impacts of climate change. In particular, the main objectives include the rehabilitation of green areas, review and expansion of urban mobility (upgrading the cycle path system, extending public transport with green investment) and a decrease in concrete surface area.

These challenges are addressed by various NBS, such as urban renewal with green areas, including the selection of climate-adapted vegetation, water- and air-permeable cover usage, and the creation of urban garden allotments.

The main financing models used for the implementation of this solution are EU and national financial sources, due to the limited budgets of local authorities. In particular, there are plans in Szeged for a joint Hungary-Serbia application from the Instrument for Pre-Accession Assistance (IPA) for improving water management and rainwater use for local gardening. All activities include at least 5-10 % co-financing from the city. There is only one project that is financed solely from the city's budget.

Benefits coming from the implementation of green areas lead to: richer biodiversity and more stable ecosystems and their services because of increased and rehabilitated green areas; better air quality because of reduced traffic, more cycle paths and more green infrastructure; and reduced run-offs and improved soil quality because of decreased sealed areas, water permeable coverage and vegetated areas.

The actors involved in the development of this project are housing estates that during planning procedures participate in debates, local residents that express their opinions during forums held at the planning and implementation stages and civil organizations.

2.1.6 The business model of Permeable Surfaces and Green Urban Areas in Clausplein (Eindhoven)

Since the city of Eindhoven wants to become a more climate robust city, the municipality intends to create 40-50 mm additional aboveground water storage for peak showers (in total 60 mm storage). One of the ways to achieve this objective is to increase the permeability and greening of urban surfaces by replacing the pavement and impermeable surfacing with vegetation, pavement with more permeable materials and/or water areas. Limiting of surface sealing and greening public areas creates space to store water and infiltrate it into the ground.

The implementation of **permeable surfaces and green urban areas** is planned in the project Clausplein (one of the several NBS locations). This is a square, owned by the municipality, with little green areas situated on the top of a parking garage. One of the goals of the project is to increase green areas implementing permeable surfaces.

Value Proposition

The city of Eindhoven is facing serious challenges due to rapid population growth. Critical issues for the city include flooding, urban heat stress, air pollution, lower quality of life and the disappearance of streams and ditches.

Increasing permeability and greening of urban surfaces, replacing impermeable surfaces with vegetation or water will allow **reducing the risk of flooding and decreasing urban heat stresses and pollution**.

Furthermore, the creation of new water systems (to be separated from the sewage system) will enable optimising the use of **water storage capacity** as well as **creating extra capacity in the sewage system** of Eindhoven.

The increase of greening of urban surfaces will also contribute to enhance **biodiversity**, and to **improve the general quality of life**. In some areas, filtering plants, such as reeds, can be used to **improve water quality**.

The following *Figure 2.2* and *Figure 2.3*[1] show the current view and the new design of the Clausplein square, with increased biodiversity and liveability.

[1] These figures are property of the Municipality of Eindhoven and can be publicly disseminated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Figure 2.2: Clausplein current view

Figure 2.3: Clausplein requalification project view

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Residents around the square: people that live in Clausplein square will benefit the creation of green surfaces improving the quality of their life.
- Municipality: the Municipality of Eindhoven owns the area and finances its renovation
- Offices: employees may benefit from access to public green spaces during their breaks, potentially improving their quality of life,
- Public libraries located in the surroundings and the design academy located in the square will enhance their attractiveness and visibility for inhabitants and students.
- The Public Health Department on the square may offer a nicer and greener environment to their users (employees, patients and citizen at large).
- City water management (Water Board): it monitors the quality of the water surface and it manages water levels in the areas where people live and work. Furthermore, it prevents floods in rural areas. The selected NBS will improve the water management system.
- City users (e.g. employees, students, patients etc.): people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit of the requalification of the area

Financing models

According to a first estimation coming from the Municipality of Eindhoven, all interventions needed for the realisation of the selected NBS foreseen public funds. Only in some situations, private parties (indirectly) share the costs incurred for projects in the public space.

Much of the funding comes from the public partners, in terms of income from taxes or licenses, funding from public bodies such as the European Community, regions, national government and utility companies. Some of the funds are generated by the municipality from selling portions of public land.

In Eindhoven, investments in public spaces are legitimised because sewage and water treatment, infrastructure, traffic management, public transport and town planning are seen as a public responsibility. In addition, inhabitants pay tax to allow the municipality to fulfil their tasks. Residents and business owners are mostly not willing to pay an extra contribution in favour of the public space[2].

[2] Considerations based on Eindhoven Municipality experience.

Since March 2018, there is a municipal green fund called “Groenfonds” that is connected to the Eindhoven regulation for the compensation of green space. If a building company needs to pave in green space, they have to make a deposit into the Groenfonds. The municipality can spend this money on certain greening projects such as the interventions in Clausplein square.
Finally, funds can be obtained thanks to the partnership with private enterprises: examples may be agreements to co-finance the project with owners of some of the buildings at the square (’Witte Dame’).

Actors involved in the implementation and maintenance of permeable surfaces and green urban areas

An active stakeholder’s involvement has been essential to perform good planning and implementation of permeable surfaces and green urban areas. The main actors involved in the implementation and maintenance of the selected NBS are reported below:

- Project leader and Policy advisor
- Designers, civil engineers, maintenance experts, area coordinators
- Contractors for construction and maintenance
- Real estate investors
- Non-government organisations
- Green platform (“Trefpunt Groen Eindhoven”), an NGO that represents green/environmental organisations
- Businesses on square
- Citizens

In the selected example, public tenders will be used to find contractors for construction and maintenance. In Eindhoven’s larger projects, tenders contain also the design of public space. Regarding the project financing, the main involved stakeholder is the municipality.

Key activities

The following *Table 2.7* identifies the key activities needed to deliver the proposition of the project.

Table 2.7: Key activities foreseen for the implementation of the permeable surfaces and green urban areas

Key activities	Description of activities
Inform, inspire and involve stakeholders	Dissemination of the purpose, advantages and benefits of the selected NBS
R&D	Selection of plants, paving materials, ways of construction and, if necessary, development/production of new materials
Construction	Implementation of the project with new material laying
Public space monitoring	Monitoring of the quality of public space by the owner of ’Witte Dame’. The actual maintenance is shared between owner and municipality
Agreement	Obtaining an investor and design agreement to proceed with the project

European Commission
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Key resources

Table 2.8 identifies the key resources needed in Eindhoven to fulfil the proposition of the selected NBS.

Table 2.8: Key resources for permeable surfaces and green urban areas

Key resources	Needed to/for…
Project leader, designers, civil engineer, maintenance experts	Procurement team planning specific knowledge and driving change and creativity
Construction/maintenance contractors	Implement and maintain the project
Money and funds (Municipality budget, subsides/grants regional, national, European)	Design, implement and maintain the NBS
Municipality	Involve, inform, inspire residents/businesses through a communication plan

Cost structure

This section collects preliminary information about the main economic and environmental costs during the implementation of permeable surfaces and green urban areas.

Costs for the implementation of permeable surfaces and green areas in the city of Eindhoven were collected from the official document of the Municipality of Eindhoven "Eindhoven goes greener" (Postmes, 2014). Direct expenses include costs for the installation, maintenance, and management as well as the replacement of paving materials at the end of its lifespan.

In particular, *Table 2.9* below provides an up-to-date overview of direct costs for the basic design of the project. Looking at the direct costs, the most important for the Municipality of Eindhoven are shown at the top of the table. The cost for both installation and maintenance increases when exclusive material and/or planting are used. The costs for the reconstruction of the Clausplein is estimated to be € 700,000, the area is about 4000 m^2. Designing and co-creation are not included in these costs. The maintenance costs are not clear yet because a new water storage system will be introduced. The maintenance of the green area maybe derived from *Table 2.9*

Table 2.9: Costs for the implementation of permeable surfaces and green urban areas

Type of costs	Implementation € per m^2	Maintenance € per m^2	Lifespan	Replacement € per m^2	Investment value [3] € per m^2
Dry grassland	2,15	0,12	100	2,15	8
Tall grass	2,15	0,22	60	2,15	14
Lawn	2,15	0,77	30	2,15	43
Forest park	6,5	1,61	70	8,5	90
Convenient shrubbery	14,85	1,1	20	16,85	104

[3] Calculated using an inflation of 1.8% and a 3.8% interest

Pavement (no drive lane)	38	1,35	60	10,5	123
Ornamental planting	14,85	2,04	20	16,85	151
Paved driving lane	59	1,46	40	61,5	183
Closed paved driving lane	75	1,16	50	90	186

Currently it is not possible to establish if the total costs will be higher or smaller with respect to the total cost of conventional solutions, but generally, as indicated in the official document "Eindhoven goes greener" of the Municipality of Eindhoven, costs of installing and maintaining manageable green spaces are considerably lower than the price of paving those areas. Costs for maintenance have not yet been evaluated. The implementation of permeable surfaces and green areas have no relevant environmental costs in addition to those related to temporary increasing of air pollution during the construction works and limited to close proximity of the construction sites.

2.1.7 The business model of Urban Gardens with Small-Scale NBS in Tampere

Urban gardens with small-scale NBS in Tampere refers to co-design and co-implement **small-scale NBS and complementary infrastructure** in the **Vuores area**. These solutions include rain gardens, rainwater collection systems for non-potable irrigation, urban garden areas and other similar solutions.

Value proposition

The main objective of urban gardens with small-scale NBS in Tampere is to enhance **social cohesion** developing **recreation areas** such as paths around lake, platforms/swimming places to the lakes, bonfire places, parks that encourage physical activities, wood for kids to play in water elements, horse-riding routes, more open landscape around lakes and parking lots to access recreational areas.

In addition, urban gardens can **improve biodiversity**: the areas will be characterised by the installation of more street/plot trees, perennial plants, insect hotels more wilderness and less controlled parks. This solution is estimated to provide attractive green areas for citizens, thus **increasing their recreation opportunities and physical activities and eventually their well-being and health**. Furthermore, these solutions allow **managing storm water** that could create floating wetlands.

Figure 2.4 shows an example of urban gardens with small-scale NBS already implemented in Helsinki. Similar solutions may be replicated in Vuores area in Tampere.

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Figure 2.4: Examples of urban gardens with small-scale NBS in Helsinki

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Inhabitants and citizens: people that live in the Vuores area will improve the quality of their life thanks to the enhancement of biodiversity, the reduction of heat stress. In particular families with children and older population may greatly benefit from the establishment of social cohesion in a socially deprived area
- City users (especially employees and students): people that do not live in the city but come regularly in the city for work or to use other services or amenities could benefit of the requalification of the area
- Municipality: the Municipality of Tampere owns the Vuores area and finance the renovation
- Green builders, maintenance and planning companies could obtain business opportunities planning, building and maintain the newly renovated area
- Investors: houses with high quality gardens (multi-functional NBS) are a good investment; these gardens provide added value for residents & make houses more attractive.

Financing models

According to a first estimation provided by the Municipality of Tampere, the implementation of this NBS will be funded by "innovation vouchers" to enable existing housing companies and other communities to co-design and co-implement small-scale NBS and complementary infrastructure and/or urban garden areas. Innovation vouchers have not been already put in place, but the municipality estimates that through the use of innovation vouchers, housing companies and other communities in Vuores may apply for 3 x 10 000 € vouchers to plan and implement communal gardens. It is expected that this will improve storm water management, biodiversity and recreational use of gardens. Private investments made by housing companies and other communities will fund the rest of the implementation not covered by innovation vouchers. In the future, similar installations will be funded by property owners.

Actors involved in the implementation and maintenance of urban gardens

In order to achieve a good implementation of the selected NBS in Tampere, public and private stakeholders have been widely involved. The main actors involved in the implementation and maintenance of urban gardens with small-scale NBS are reported below:

- Housing companies, communities and residents are involved in the co-design and co-implementation of urban gardens.

- Tampere Municipality is involved in the project with the role of co-definition of demonstration aims, supervision according to the aims and stakeholder engagement.
- UNaLab project coordinator VTT facilitates communication between other UNaLab activities, especially indicator and monitoring development.
- Research institutions are involved in related and nearby located NBS/city green projects.
- SMEs are involved in the selling of new products and services needed and in replication and information spreading. Activities performed are e.g. maintenance and monitoring services.
- Builders are involved in the construction of the green infrastructure and in the replication and information spreading.
- Landscape planners are involved in the planning of the demonstration and in the replication and information spreading.
- Citizens (co-creation participants, Vuores visitors, students, NGOs) are involved in mobilising results. The main activities performed are participating in Vuores site visits.

Key activities

Table 2.10 identifies the key activities needed to implement urban gardens and reach the aim of the project.

Table 2.10: Key activities foreseen for the implementation of the urban gardens

Key activities	Description
R&D	Consulting previous R&D projects, setting monitoring program according to the aims, analysing results, mobilising results (e.g. temperature, water quantity and quality, biodiversity, effects to building structures, moistures)
Renovation and requalification	Renovation and requalification of the area through the installation of multi-functional small scale NBS into communal urban gardens mainly in private land (plots)
Frequent maintenance	Learning new maintenance practices that again meet the aims, new actors are needed, and heavy maintenance may not be feasible
Stakeholder engagement	To build urban gardens that meet aims and is replicable, requires interaction with many internal (city units) and external stakeholders.
Promotion	Marketing and branding promotion involving stakeholders and mobilising results

Key resources

In order to implement urban gardens in a successful way in the Front-runner City of Tampere, a series of resources is needed. The following *Table 2.11* identifies the key resources needed to fulfil the proposition of the project.

Table 2.11: Key resources for urban gardens

Key resources	Needed to…
Planners and green experts	Implement and maintain urban gardens in the Vuores area

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Money and funds (EU + municipality)	The replication of the construction phase for companies/investors
Marketing and advertising materials	Involve stakeholders and mobilise results

Cost structure

This section collects the preliminary information about the main economic costs needed for the implementation of urban gardens in the Vuores area in Tampere.

According to a first cost estimation coming from the Municipality of Tampere, the following *Table 2.12* summarises the main types of cost to be taken into account for the implementation and maintenance of urban gardens.

Table 2.12: Costs for the implementation of urban gardens

Type of costs	Cost for implementation
Planning	ca. 3000-5000 € depending on the scale of the plan
Implementation	ca. 5000-15000 € depending on the scale of the plan
Maintenance	ca. 3-12 €/m2 Actually residents are going to maintain gardens voluntarily
Monitoring	To be determined

Regarding the maintenance, if we consider Horse Park, horses maintain the field together with the manual work for picking horse manure from the park in events. In addition, the city is cutting the hay once a year with a small tractor.

2.2 River restoration – Business Model examples

According to the European Centre for River Restoration (ECRR), river restoration refers to a large variety of ecological, physical, spatial and management measures and practices. These are aimed at restoring the natural state and functioning of the river system in support of biodiversity, recreation, flood management and landscape development (ECRR, 2014).

By restoring natural conditions, river restoration improves the resilience of the river systems and provides the framework for the sustainable multifunctional use of estuaries, rivers and streams. After restoration the rivers are characterised by dynamic water courses and sediment movements. Some of the mentioned functions are storm water regulation and flood risk reduction, habitat provision, and the provision of public space for recreation. The measures of restoration are diverse and modify different parts of the river e.g. the riverbed, the riverbank or floodplains and include small-scale as well as larger scale interventions.

River restoration involves a wide range of stakeholders from the public and private sector including policy makers, practitioners, scientists and non-government organisations, as well as all citizens groups potentially impacted. By actively drawing these various stakeholders into the process, visions can be shared and tuned towards each other. This makes for different interests to be met, and increases support for restoration efforts.

The following *Table 2.13* resumes main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits of river

restoration, considering the desk research, the analysis of the NBS implemented in Front-runner Cities and information provided in the *D5.1 NSB Technical Handbook.*

Table 2.13: Features, value proposition, conditions for implementation, stakeholders, costs, financing options and limits of river restoration

Features
• Opening of covered/buried watercourses (rivers, drainage systems) by removing concrete layers • Daylighting leads to more space for the water; increased storage capacity of the channel • Storm water benefits/management; environmental, aesthetic co-benefits • Architectural restoration describes the daylighting of the channel that still follows a concrete/constructed channel (less near-natural than channels of the first type) • Expansion of the flood plain area • Providing additional flood space by excavating the lateral river bed (flood plain area) • Newly created space can be used for e.g. Public purposes (relaxing, leisure activities) or agricultural purposes (farmland) during low water levels
Value proposition/Benefits
• Flood risk reduction • Flood protection • Amenity value/recreation • Habitat quality reducing heat stress • Storm water management and storage • Benefits for aquatic organism • Ecological benefits • Improving physical habitat conditions of the watercourse, habitat niches • Aesthetic value and human recreation • Optimisation of water storage capacity • Biodiversity enhancement • Water quality
Conditions for Implementation
• Restriction/limited possibilities in highly dense and build-up areas because of the high cost for shifting of infrastructure/removing of infrastructure • Certain channel width • Need to assimilate knowledge about soil types under/surrounding the channel to guarantee the performance of the daylighting measure • Infrastructure near the river or other types of land use can be seen as a limitation for river restoration, if there is a need for preservation (limited space)
Limitations/Barriers
• The establishment of flora and fauna is limited • Restriction of the establishment of animals and plants and therefore a limitation of the provision of ecosystems for wildlife
Stakeholders/Beneficiaries | **Costs**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

• Inhabitants having interest in the water and natural resources management • City water management (Water Board) • A municipality can finance the renovation of the area • Local businesses (e.g. shops, restaurants, café real estate agencies, professional associations etc.) may increase their earnings attracting more people in the area • Offices: employees may benefit from the reduction of heat stress in the area as well as access to the watercourse • City users (e.g. employees and students): people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit of the requalification of the area • Policy makers, practitioners, scientists and non-government organisations can establish an alliance to cooperate with the project	Costs are mainly paid by private as well as public entities. In particular, the municipality and the water board department are engaged in the reconstruction of the watercourse, while developers usually pay for the construction of the park (if established). The costs may vary considerably. In a previous EU- funded project in Lotz, implementation costs were approximately 700000 Euros. The project in Munich costs approximately 35 million euros: 28 million euros in construction costs, 7 million euros for the remediation of contaminated sites.
Financing options	
• Innovative municipal financing approaches o Municipal investment: municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance.) o Accessing external funding sources: for example regional, national and EU and/or other funds can be an important source of NBS financing o Cross-departmental budget: NBS financing could be enhanced by promoting the communication, cooperation and cost sharing across the budgets of different municipal departments or cross-departmental budgets for the multidisciplinary interventions • Public-Private partnerships o Mobilising investment from municipal enterprises/utilities: Municipalities and municipal companies might want to co-invest in interventions that support achieving their strategic and political goals. • Mandatory Requirements and Tax Initiatives o Land value & value-capture taxation: for example the Zoning Plan of investments in Eindhoven includes the obligation to contribute to reconstructing the Gender for the owner of the land/building, which lives near the Gender. In exchange, the land/building owners are allowed to build more building units	

2.2.1 Case studies of river restoration beyond UNaLab

An example of this kind of NBS is the urban river restoration in Lodz (Poland), representing a sustainable strategy for storm water management (Climate-ADAPT, 2014).

The project consists of the restoration of municipal rivers based on natural processes with the aim to improve storm-water management, increase water retention and better water quality supporting higher biodiversity and improvement of quality of life.

The project involved all the actors in the city having an interest in the water and natural resources management as well as regional and national stakeholders. In particular, the cooperation between stakeholders was substantially enhanced through the establishment of the Learning Alliance in Lodz - a stakeholder forum for exchanging ideas, plans and interests, with allocated EU funds for its activities. The key stakeholders in the Lodz Learning Alliance included partners from different organisations, research institutes and municipal departments.

EU funding was vital to the project. The total project budget was €1,150,000. The demonstration project had a budget of approximately € 700,000. About € 130,000 was invested in the Learning Alliance activities.

Another example of river restoration is the Water management plan and restoration of the Isar River in Munich (Germany) (Climate-ADAPT, 2015b).

The case study describes the flood risk management plan and the related restoration of a formerly canalised eight kilometer stretch of the Isar River in the city of Munich (the so called "Isar Plan"). The main objectives of this project are the improvement of flood control by increasing the water retention capacity of the river stretch, biodiversity in terms of habitats for wild species and recreational quality due to the growing need for recreational space within a dense urban area, i.e. access to waterline, attractive landscape and views.

In order to develop this project, an interdisciplinary working group was initiated. It was composed by different members such as the State Office of Water Management Munich, the City of Munich (Department of Public Construction, Department of Urban Planning and Building Regulation and Department of Health and Environment) and the "Isar-Allianz" (an alliance of NGOs). The working group examined the flood-water situation, the need for recreational areas at the riverside and the area's animal and plant worlds and their habitat. Public participation was ensured through: internet platform, info-brochures, excursions, workshops, TV and press, round tables, info-points, service telephone.

Approximately 35 million euros were spent in total for the project: 28 million euros in construction costs, 7 million euros for the remediation of contaminated sites and the removal and disposal of weapons from the Second World War. Costs were split between the Bavarian State Government (55%) and the City of Munich (45%).

2.2.2 The business model of Re-Establishment of Watercourses (Daylighting) in Victoriapark (Eindhoven)

Almost 20 years ago, Eindhoven started the reconstruction of watercourses in order to make the water system visible, by removing concrete layers. This strategy allows creating a more robust and as natural as possible water system removing concrete layers. In particular, the re-establishment of watercourses (daylighting) is planned in "Victoriapark" (one of the several NBS locations). One of the goals of the project is to uncover sections of covered watercourses with the aim to re-establish water courses and manage water flows.

In the following *Figure 3.4*, photos showing the current design of Victoriapark area is reported.

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Figure 2.5: Victoriapark – Current design[4]

Value proposition

The city of Eindhoven is facing critical issues from the environmental point of view, including floods, urban heat stress, air pollution, lower quality of life and the disappearance of streams and ditches.

A way to solve most of these problems consists on the re-establishment of watercourses, creating at the same time new water systems **to optimise the use of water storage capacity** as well as **to create extra capacity in the sewage system** of Eindhoven. The re-establishment of watercourses contributes to enhance **biodiversity**, to **reduce heat stress** and to **improve the general quality of life**.

Among the benefits coming from the implementation of the selected NBS there are **storm water management, flood risk reduction, amenity value/recreation, habitat quality, benefits for the aquatic organism** (light plays an important role for population movement) and **aesthetic value** for the human recreation.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are very similar to those reported for the previous NBS located in Clausplein, since the proximities of the two areas. In summary, they are:

- Inhabitants of buildings around the park benefiting from the re-establishment of watercourses improving the quality of life thanks to the enhancement of biodiversity and the reduction of heat stress.
- City water management (Water Board)
- Café and Restaurants near the park may increase their earnings: the implementation of the selected NBS may contribute to attracting more people in the area, increasing the opportunities for commercial activities.
- Offices near the park: employees may benefit from the reduction of heat stress in the area as well as access to the watercourse.
- Libraries and Design Academy next to the Park may increase their attractiveness for visitors and students.
- City users (e.g. employees, students etc.) : people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit of the requalification of the area

[4] Figures are property of the Municipality of Eindhoven and can be publicly disseminated.

Financing models

As all other NBS selected by Eindhoven and described in the present deliverable, the watercourse daylighting project in Victoriapark foresees mainly the use of public funds (e.g. municipality through inhabitant taxes and/or income by selling public spaces, European Community, regions, national government and public owned utility companies etc.).

In particular, in this case, funds can be obtained from the Zoning Plan of Eindhoven[5] that includes the obligation to contribute to reconstructing the Gender for the owner of the land/building, which lives near the Gender. In exchange, the land/building owners are allowed to build more building units.

Finally, the Water Board agreed on paying part of the investment costs for the reconstruction, which will positively impact on the water sewage system.

Actors involved in the implementation and maintenance of re-establishment of watercourses

The following actors will be involved in NBS implementation and maintenance of the selected NBS:

- Project leader and policy advisor
- Designers, civil engineers, area coordinators
- Real estate investors (i.e. building/land owners)
- Non-government organisations
- Water Board
- Green platform (”Trefpunt Groen Eindhoven”), an NGO that represents green/environmental organisations
- Shop owners in the park
- Citizens

Key activities

Table 2.14 identifies the key activities needed in Eindhoven to deliver the proposition of the project.

Table 2.14: Key activities foreseen for the implementation of the re-establishment of watercourses

Key activities	Description of activities
Inform, inspire and involve stakeholders	Dissemination of the purpose, advantages and benefits of the selected NBS
R&D	Selection of the best water systems involving water, retaining and green experts for the water flows management
Implementation	Implement the project with the involvement of designers
Maintenance	The maintenance of the water course will be performed by (paid for by) the Water Board. The park will be sold to the municipality for 1

[5] Zoning is the process of dividing land in a municipality into zones (e.g. residential, industrial) in which certain land uses are permitted or prohibited. The Zoning Plan of Eindhoven is public and available upon request.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

	euro, after which maintenance of the park will be paid for by the municipality.
Agreement	Obtaining investor and designer agreement to proceed into the project

Key resources

The following *Table 2.15* identifies the key resources needed in Eindhoven to fulfil the proposition of the selected NBS.

Table 2.15: Key resources for re-establishment of watercourses

Key resources	Needed to/for…
Project leader, designers, civil engineer, maintenance and water experts	Procurement team planning specific knowledge and driving change and creativity
Construction/maintenance contractors	Implement and maintain the project
Money and funds (Municipality budget, subsides/grants regional, national, European)	Design, implement and maintain the NBS
Municipality	Involve, inform, inspire residents/businesses through a communication plan

Cost structure

No information about the costs needed for the re-establishment of watercourses in Victoriapark is available yet. However, according to a first estimation coming from the Municipality of Eindhoven, costs will be paid by private as well as public entities. In particular, the municipality and the Waterboard will pay for the (re)construction of the watercourse, while the developer will pay for the construction of the park.

2.3 Green Roofs and Vertical greening– Business Model examples

Green roofs are vegetative layers implemented on rooftops - especially in urban areas - with the aim to provide green space for different purposes and mitigate urban heat islands. Depending on the type of green roof installed, the plants may be modular or have drainage layers. However, all green roofs include a few important features, such as waterproofing and root repellent, to keep the structure safe and undamaged.

Several types of green roofs with varying coverings, complexity and scopes can be implemented on rooftops. Main positive effects associated with green roofs are for instance cooling and evapotranspiration, which lead to a reduction of the roofs temperature itself as well as of the surrounding air (air cooling). As a result, green roofs contribute to mitigating negative effects in urban areas, in particular caused by urban sealing, buildings and heat emissions.

Maintenance is the most important part of the green roof top for both the plantation as well as the building. A proper check is required once a while to see if the installation is perfect and no leakage is there.

Actors involved in green roof projects are usually engineers that give feasibility analysis report of the building with respect to green roof installation, experts on green roof installation guiding

the installation process, gardeners physically working along with maintenance and office employees that manage accounts and the office work.

Green wall or vertical greening is used as the general term for any vegetation cover on vertical surfaces, no matter where the roots are located. Similar to green roofs vertical greening can be differentiated according to the level of technical support that is needed to sustain vegetation. However, since vertical soil itself has no model in natural settings, almost all types of vertical greening are "intensive" and therefore different characteristics are used to describe vertical greening. The main differences of vertical greening types are greening of facades (buildings), free standing living walls, moss walls, living plant construction and potentially vertical open spaces.

The following *Table 2.16* resumes main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits of green roofs and vertical greening, considering the desk research, the analysis of the NBS implemented in Front-runner Cities and information provided in the *D5.1 NSB Technical Handbook*.

Table 2.16: Features, value proposition, conditions for implementation, stakeholders, costs, financing options and limits of green roofs and vertical greening

Features

• Green roofs are often associated with residential buildings, hotels or underground parking
• Higher installation, maintenance, management effort (regular irrigation and fertilisation) which leads to higher costs
• Intensive green roofs:
  o vegetation is often established on roofs that are accessible for public or recreation purposes and also for regular maintenance measures
  o Appropriate plants are mainly trees, shrubs and perennials
  o Different kinds of architectural elements (buildings, solar panels) can be established
• Extensive green roofs:
  o light weight systems, characterised by minimum maintenance and management
  o the installation and management/maintenance is less expensive than that of intensive systems
  o extensive green vegetation is often established on roofs that are not accessible or with limited access for public or recreation purposes (but annual maintenance) and partially characterised by steep slopes
  o Selected plants are generally well adapted to alpine environments/climate and tolerate different climate conditions (e.g. drought) and temperature fluctuations.
  o A limited number of different plant species
  o Smart roofs represent an extension of conventional green roofs because the system is equipped with a drainage system under the vegetation layer that retains storm water
• Vertical layering of soil/substrate which is stored in metal cages with supporting elements to create walls of up to 4 m.
• Fabric (organic or inorganic) is used to prevent the substrate/soil from eroding from the cages.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

- Fairly heavy construction which rests on a simple strip foundation.
- Living wall needs to be constructed in two segments (minimum) that form a right angle in order to stabilize the living wall.
- Very flexible with regard to plant selection, as long as irrigation and fertilizer can be managed accordingly.

Value proposition/Benefits

- Enhanced biodiversity, human health and quality of life
- Public access to green recreation areas
- Storm water/rainwater management and quality increasing water retention
- Improved air quality (reduction of greenhouse gas emissions and pollution)
- Aesthetic value/visual attractiveness
- Additional space (intensive roof)
- Thermal performance/temperature reduction (air cooling and evapotranspiration)
- Energy reduction for buildings (heating/cooling)
- Reduction of noise/sound transmission
- Habitat provision for urban wildlife
- Reduced flood risk and slope stability
- Beneficial for selected species if respective plants are used
- Carbon storage capacity

Conditions for Implementation

- Site characteristics often depend on project objectives
- Solid, stable concrete buildings/bearing capacity
- Flat or relatively flat concrete rooftops and underground concrete structures
- Artificial irrigation but at least (rainwater) watering facility in critical/dry periods
- In some cases special plates to distribute pressure on the rooftop are needed (for planters)
- In the case of smart roofs: waterproofing surface/roof and sufficient roof load-bearing capacity
- Because of the thickness of the living wall, there is hardly any problem with central European frost periods
- Underground needs to be loadable in order to support the wall
- Little risk of fire because of constant irrigation

Limitations/Barriers

- Limited development of undisturbed habitats because of human activities/public purposes
- Limited spread of flora and fauna because of regular maintenance and management
- Limited space for roots
- Irrigation is needed (summer and winter) but it should not rely on drinking water
- Supporting underground is needed
- Free standing living wall may act as a barrier for pedestrian movement
- Availability of an adequate location

Stakeholders/Beneficiaries	Costs
• Residents and citizens: people that live in the city will improve the quality of their life thanks to the enhancement of biodiversity and the reduction of heat stress. In particular families with	Costs vary significantly depending on a large number of variables such as the size, location and accessibility of the site, the types of plants that are going to be grown on it, the type of structure, the design, the distances for

children, older populations, students may benefit from the new opportunities for recreation available where the green roofs are open to the public. • Municipality and building/housing companies can finance the renovation. Building/housing companies will benefit from the increased value of the buildings. • Local businesses (e.g. hotels) may benefit from the increased attractiveness and improved aesthetic appearance of the city, which will have a diffuse network of carefully designed green façades and roofs. Offices: employees may benefit from the reduction of heat stress in the area • City users: people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit from the requalification of the city • Green builders and green roofs providers/developers together with maintenance and planning companies may new obtain business opportunities for planning, building and maintaining new green areas • Investors: houses with green roofs are a good investment; green roofs provide added value for residents and make houses more attractive	transport, the storage of materials on or off-site, the access for mobile cranes, access to goods lifts, the roof height, dimensions and load-bearing capacity, the roof construction, complexity of roof design including roof penetrations and the timing of project. • Material and Installation costs ≈ 100-200 €/m2 • Maintenance costs ≈ 3-12 €/m2 per year • Planning ≈20 €/m2 • Monitoring costs ≈ 15 000 € • Costs for the reinforcement of roofs, which may be necessary to withstand the increased load due to the installation of trees and vegetation ≈123 €/m2

Financing options

- Innovative municipal financing approaches
  - Municipal investment: municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance.
  - Accessing external funding sources: for example regional, national and EU and/or other funds can be an important source of NBS financing
- Public-Private partnerships
  - Mobilising investment from municipal enterprises/utilities: Municipalities and municipal companies might want to co-invest in interventions that support achieving their strategic and political goals.
  - Tax increment financing (TIF): an anticipated increase in property tax assessed on the increase in property value due to a development project implemented in that area. For example the funds can provide partial reimbursement to commercial buildings that install green roofs.
- Mandatory Requirements and Tax Initiatives

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

- Private sector financing: for example in Tampere private developers and building owners support the NBS implementation by setting up green roofs on their properties

- Incentive programmes
  - Private sector financing: for example in Tampere private developers and building owners support the NBS implementation by setting up green roofs on their properties
  - Grants to private property owners and community groups: Cities can provide money to private entities directly for green infrastructure practices or promote them indirectly through low-impact development competitions. For example programmes offering financial incentives to install green roofs on buildings.

2.3.1 Case studies of green roof and vertical greening beyond UNaLab

The first example of green roof application is the project developed in Basel (Switzerland) with the aim to combine mitigation and adaptation measures (Climate-ADAPT, 2015a).

The city of Basel in Switzerland has the largest area of green roofs per capita in the world and it promoted green roofs via investment in incentive programmes, which provided subsidies for green roof installation. The main objective of the green roof installation project was the mitigation of the urban heat island effect.

Various stakeholders were consulted when developing the green roof concept and in establishing the first incentive programme: the local business association, the horticultural association, the green roof association, the Pro Natura Basel environmental organisation, the Department of Parks and Cemeteries in the City of Basel and the National Department of Environment, Forest and Landscapes.

The initial costs of roof greening were estimated as 90 €/m2. Beneficiaries of the fund received 18 €/m2 of the green roof, for both new developments and for retrofitting green roofs to an existing building.

Another example refers to the verticalisation of green spaces and, in particular, to free standing living wall. The case study reported is the “Green Living Room” in Ludwigsburg (Germany), an innovative green urban space on heavily sealed surfaces of an inner city location. In particular, the project aims to create an innovative multifunctional green urban space which fosters climate change adaptation measures contributing to enhancing urban climate comfort on heavily sealed surfaces (Oppla, n.d).

One of the key resources needed for the implementation of the Green Living Room was the availability of an appropriate space. The construction process was based on specific technical knowledge related to living plant construction and green wall systems.

The project received funding from the City, the EU commission as well as from producers of plant systems and counted with the support of different partner's staff.

2.3.2 The business model of Green Roofs/Green Building Façades in Eindhoven

Green roofs are vegetative layers implemented on rooftops for multiple purposes. They contribute to the mitigation of negative effects in urban areas, in particular caused by urban sealing, buildings and heat emissions. The idea of green roofs is based on natural processes of vegetation, such as water evaporation, temporary storage and buffering as well as sunlight absorption. Several types of green roofs with varying coverings, complexity and scopes can be established on rooftops.

Vertical greening is used as a general term for any vegetation cover on vertical surfaces, no matter where the roots are located. Similar to green roofs, vertical greening can be differentiated according to the level of technical support that is needed to sustain vegetation. *Figure 2.6* shows an example of green roofs and green building façades already installed in Eindhoven.

Figure 2.6: Examples of green building façade and green roofs (Eindhoven, Medina)[6]

Value proposition

Green surfaces are often associated with residential buildings, hotels or underground parking. Main positive effects coming from them are for instance **cooling and evapotranspiration** (5-20% sunlight is used for photosynthesis, 20-40% is used for evapotranspiration 10-50 % transformed into heat 5-30% reflection), which lead to **a reduction of the temperature surface** itself as well as of the surrounding air (= **air-cooling**).

Plants, in fact, **reduce air pollution**, producing fresh air with low proportions of particulate and polluting gases (reduction of greenhouse gas emissions). Among the other benefits, green surfaces allow managing temperature and thus **decreasing the energy required for buildings heating and cooling.**

Green façades and roofs contribute to **enhance biodiversity and human health and quality of life** and create an **aesthetic value** and **visual attractiveness**.

Furthermore, green building façades and green roofs contribute to improving the **rainwater management and quality, increasing water retention** of 15-30%.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Inhabitants and citizens: people that live in the city will improve the quality of their life thanks to the enhancement of biodiversity and the reduction of heat stress.
- Offices: employees may benefit from the reduced heat stress of the area.
- Hotels may benefit from the increased attractiveness and improved aesthetic appearance of the city, which will have a diffuse network of carefully designed green façades and roofs.
- City users: people that do not live in the city but come regularly in the city for work or to use other services or amenities could benefit from the requalification of the city

[6] Figure taken from the deliverable *D5.1 NBS Technical Handbook*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Financing models

For the implementation of the selected NBS, funds come especially from the building owners that are responsible for the realisation of the project. However, the municipality may contribute to the greening of privately owned buildings.

Actors involved in the implementation and maintenance of re-establishment of green roofs and green façades

An active stakeholder's involvement has been essential to implementing green roofs and green building façades. The main actors involved in the implementation and maintenance of the selected NBS are reported below:

- Project leader and Policy advisor
- Designers, civil engineers, area coordinators
- Non-government organisations
- Building tenants/leaseholders/operators
- Citizens
- Municipality

Key activities

Table 2.17 identifies the key activities needed in Eindhoven to deliver the proposition of the project.

Table 2.17: Key activities foreseen for the implementation of the green roofs and green building façades

Key activities	Description of activities
Inform, inspire and involve stakeholders	Dissemination of the purpose, advantages and benefits of the selected NBS
R&D	Selection of the best solutions/design for green façades and roofs.
Installation	Higher installation of "green" that includes the choice of suitable plants
Procurement	Privately owned buildings are responsible for their own procurement. For some of the municipality buildings, there is a procurement for sustainable development for 15 years.
Agreement	Obtaining an investor and design agreement to proceed into the project
Management and maintenance effort	Regular irrigation and fertilisation of roofs and façades

Key resources

Table 2.18 identifies the key resources needed in Eindhoven to fulfil the proposition of the selected NBS.

Table 2.18: Key resources for green roofs and green building façades

Key resources	Needed to/for…
Project leader, designers, civil engineer, maintenance and green experts	Procurement team planning specific knowledge and driving change and creativity
Construction/maintenance contractors	Green experts are in charge of the implement and maintain the project
Money and funds (Municipality budget, subsides/grants regional, national, European)	Design, implement and maintain the NBS
Municipality	Involve, inform, inspire residents/businesses through a communication plan

Cost structure

Costs for the implementation of green roofs and green building façades vary significantly depending on a large number of variables such as the size, location and accessibility of the site, the types of plants that are going to be grown on it, the type of structure (and any need for structural reinforcement), the design, the distances for transport, the storage of materials on or off-site, the access for mobile cranes, access to goods lifts, the roof height, dimensions and load-bearing capacity, the roof construction, complexity of roof design including roof penetrations and the timing of project.

However, according to a first estimation coming from the Municipality of Eindhoven, costs for installing and maintain a green roof or a green building façade are summarised in *Table 2.19*.

Table 2.19: Costs for the implementation of green roofs and green building façades

Type of costs	Cost for implementation
Manufacturing	To be determined
Installation	€ 40-50 /m2
Maintenance	Minimal (primarily just basic plant care)

Typical maintenance costs include irrigation water, fertiliser, replacement plants, weeding and pest and disease management. Periodic inspection and maintenance of the site, from the irrigation system to clearing drains to re-tensioning of cables or repair of loose wall fixings, will be needed.

Costs will be paid by the building owners. Privately owned buildings may be subsidised by the municipality.

The business model of Green Roofs in Tampere

The implementation of green roofs aims to manage water flows (storage) and their quality, with a particular focus on their performance during cold seasons. Suitable species of vegetation will be planted in order to resist in the sub-arctic climate with changing freezing-melting cycle and snow load as well as to support native species and enhance biodiversity.

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

The area involved in the implementation of a **green roof** in Tampere is located in **Hiedanranta**, a brownfield area transformed into a housing district. In particular, a green roof will be implemented and tested above the "Old water treatment plant" that is one of the city owned and protected buildings. The future use of the building is not yet defined, but the current flat roof needs to be renovated. *Figure 2.7* shows the current Hiedanranta brownfield area.

Figure 2.7: Hiedanranta brownfield area[7]

Value proposition

The main environmental benefits expected from the implementation of green roofs are linked to **storm water management**. In particular, in Tampere, the main purpose of a green roof is to retain storm water in dense areas. The nature-based storm water management system in Tampere and especially in Hiedanranta, is based on the decentralisation principle: green roofs serve as a first step of the system. Water is retained in building plots, before they are led to a nature-based system in public green areas.

In addition, green roofs can **improve biodiversity** especially in dense areas, providing **attractive green areas for citizens,** which will affect their **quality of life: in fact** in some cases, it will be also possible to open green roofs as public parks, thus increasing the **public access to the green recreation area.** This is important, as the city is growing and especially becoming very dense.
Furthermore, **carbon storage capacity** obtained by installing green roofs is considered an interesting solution for Tampere, as its aim is to become a carbon neutral city by 2030.

Regarding biodiversity and plants, the main objectives of the city are:

- creating a high (rooftop level) green network (flora & fauna);
- availability of novel city green to support recreation and health of people;
- encouraging diversity in green roofs (native species, bushes, shrubs, pollinators, etc.)
- testing the adaptation to heavy climate conditions
- increased knowledge of maintenance practices

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Citizens and residents: people living in the city and, in particular, near the Hiedanranta area will improve the quality of life thanks to the enhancement of biodiversity and the reduction of heat stress. In particular families with children, older populations, students may benefit from the new opportunities for recreation available where the green roofs are open to the public.

[7] Figure is property of the Municipality of Tampere and can be publicly disseminated

- Municipality and building/housing companies: the Municipality of Tampere together with the building/housing companies own the building and finance the renovation. Building/housing companies will benefit from the increased value of the buildings.
- Green builders and green roofs providers/developers together with maintenance and planning companies may new obtain business opportunities for planning, building and maintaining new green areas
- Investors: houses with green roofs are a good investment; green roofs provide added value for residents and make houses more attractive

Financing models

According to a first estimation coming from the Municipality of Tampere, the dominant financing model is represented by building owners that fund green roofs due to their interest in this solution.

Public buildings such as schools and health centres are funded by public investments (municipality), while residential buildings are usually privately owned (first investor/construction companies and later housing companies) and so they make the investment.

Finally, funds come from the EU Commission for the demonstration of the selected NBS.

Recently a storm water fee (amounting in total 5,6 million €/year)[8] was introduced targeting the storm water management activities, and contributes to the funding of the implementation and maintenance of the selected NBS (Tampere Municipality, 2018)

Actors involved in the implementation and maintenance of re-establishment of green roofs

In order to achieve a good implementation of the NBS in Tampere, public and private stakeholders have been widely involved. The main actors involved in the implementation and maintenance of the green roofs are reported below:

- The municipality of Tampere, involved in the project with the role of co-definition of demonstration aims, supervision and stakeholder engagement. Owner of the renovated/demonstration building and leader of Hiedanranta area development project, which includes “innovation platform” activities, are mainly involved.
- Ramboll has the role of green roof expert, stakeholder engagement and project management duties. The main activities performed are related to the planning stage.
- Construction companies (large companies/investors of apartment houses) have the role of guiding the demonstration and bringing in future investor viewpoints (important for replication), mobilisation of results.
- UNaLab project coordinator VTT is involved in the steering group. The main activities performed are communications between other UNaLab activities, especially indicator and monitoring development.
- The University of Helsinki is involved in the steering group. In addition, other research institutions involved in related and nearby located NBS/city green projects are being contacted. The main activities performed are bringing in the earlier research knowledge of green roofs.

[8] Figures from Municipality of Tampere

European Commission
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

- Associations (Green infra building, VYRA) are involved in the steering group. The main activities performed are bringing in green infra building expertise and mobilising results.
- SMEs are involved in the selling of new products and services needed. The main activities performed are e.g. growth media, plants, building materials, monitoring devices, maintenance and monitoring services.
- Builders (building and green) are involved in the construction of the NBS
- Citizens (co-creation participants, residents, Hiedanranta visitors, students, NGOs) are involved in the co-creation, testing, maintenance and monitoring. The main activities performed are the participation in UNaLab and other co-creation activities, site visits to green roof demo, changing knowledge and iterating plans.
- Kitia (City property office) is a public body involved in the project with the role of the building owner. The main activities performed are maintaining the building (in a change of green roof maintenance after the UNaLab project).

Key activities

Table 2.20 identifies the key activities needed to implement a green roof and reach the aim of the project.

Table 2.20: Key activities foreseen for the implementation of the green roofs

Key activities	Description
R&D	Consulting previous R&D projects, setting monitoring program according to the aims, analysing results, measuring parameters/estimating results (e.g. temperature, water quantity and quality, biodiversity, effects to building structures, moisture)
Renovating/constructing the roof	The construction according to the aims requires new actors, products and services
Frequent maintenance	Learning new maintenance practices that again meet the aims, new actors are needed and heavy maintenance may not be feasible
Stakeholder engagement	To build a novel green roof that meets aims and is replicable, requires interaction with many internal (city units) and external stakeholders.
Promotion	Marketing and branding promotion involving stakeholders and mobilising results

Key resources

In order to implement green roofs in a successful way in the Front-runner City of Tampere, a series of resources and activities is needed. The following *Table 2.21* identifies the key resources needed to fulfil the proposition of the green roofs.

Table 2.21: Key resources for green roofs

Key resources	Needed to/for…
Planners (Ramboll+ steering group)	Plan the demonstration according to the aims

Money and funds (EU + municipality)	The construction phase for companies/investors
Marketing and advertising materials	Involve stakeholders and mobilise results
New knowledge	Achieve optimal solution and useful results

Cost structure

Costs needed for materials and the installation of green roofs in the city of Tampere are currently under evaluation (the project is ongoing). However, according to a first cost estimation coming from the Municipality of Tampere, *Table 2.22* summarises the main types of cost to be taken into account for the implementation and maintenance of green roofs. Costs for maintenance include the costs for water control.

Table 2.22: Costs for the green roofs[9]

Type of costs	Cost for implementation
Planning	20 €/m2
Material and Installation costs	70-250 €/m2 for sedum roof/"smart" solutions
Maintenance costs	3-12 €/m2 per year
Monitoring costs	15 000 €
The costs for the reinforcement of some roofs, which may be necessary to withstand the increased load due to the installation of trees and vegetation	123 €/m2

2.3.3 The business model of Vegetated Gabions in Genoa

Vegetated gabions are terraced systems of gabions made of wire mesh with shattered debris from demolitions and shrubs planted in the interstitial space at various levels. The aim of this system is to create containment walls steps with integrated seats and/or renovated terracing with roofing in the shrubbery.

[9] Cost estimation coming from the Municipality of Tampere

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Figure 2.8: Example of Vegetated Gabion [10]

Value proposition

One of the most common uses for gabion stone is as retaining wall to **stabilise a slope** and to control erosion (particularly in overly wet climates). Some of the main benefits of their implementation are listed below:

- Sustainability. Vegetated gabions stones can be used as shade screens in order to provide **passive cooling** (as they allow air to move through them, providing ample ventilation).
- Permeability. Vegetated gabions stones make walls to be water retaining due to their permeability and free draining – water will be able to pass through them easily whilst the stones will not be washed away. The system **reduces the risk of flooding**.
- Ease of installation. Vegetated gabions stone are easy to install – they can be joined together onsite using metal twists.
- Long Lasting. Vegetated gabions stone are long lasting, as they are made from steel and are designed to withstand all weather conditions. Even growing vegetation on the wall will have no impact on their duration.

Furthermore, the implementation of this NBS, besides helping to efficiently solve problems related to the **slope stability** and the **meteoric water management**, contributes to increasing biodiversity of vegetation, insect and other micro fauna.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are very similar to those relevant for the previous NBS because all NBS selected by the Municipality of Genoa will be implemented in the same area. They are:

- Inhabitants and citizens: people that live in the city and/or property owners in the area, in particular, near the Cinque Santi valley will benefit of the gabion stone system since it allows the access to a fairly impervious area
- Municipality: the Municipality of Genoa owns the area and finances its renovation
- Local businesses: the requalification of the area and the improvement of the quality of life within the city and the district may attract investments, commercial activities and other general businesses.

[10] Figure is property of the Municipality of Genoa and can be publicly disseminated.

Financing models

As for the other Genoa's selected NBS, the planned interventions need public funds to their realisation. However, private sponsors, with the support of citizens' associations could be involved especially for the maintenance of the NBS.

Actors involved in the implementation and maintenance of vegetated gabions

The following actors will be involved in NBS implementation and maintenance of the selected NBS:

- Municipality of Genoa
- Liguria Region
- Citizens and Local/voluntary associations
- University of Genoa
- Business associations (engineers, architects, biologists and others) that have an understanding of stream restoration, fluvial geomorphology and vegetation and habitat requirements
- Tenants of building nearby the area (e.g. B&B, social services, student rooms)

Key activities

The following *Table 2.23* identifies the key activities needed to deliver the proposition of the vegetated gabions stone.

Table 2.23: Key activities foreseen for the implementation of the vegetated gabions

Key activities	Description
Hydraulic survey	Specific analysis on the ground water table, ground water fluctuations, permeability analysis of the soil
Periodic maintenance	Gabions typically require very little maintenance. The inspection of gabions allows periodically checking any settlement, scour, damaged wire mesh or wire corrosion and excessive growth of bushes, trees, weeds and other vegetation.
Green cover	Gabions can be seeded with grass or other vegetation if the soil is intermixed with the lifts of stone and if the hydrology is not limiting.
Implementation	The installation of gabions stone does not always require heavy equipment, but the filling and closure of the gabions can be very labour-intensive. A good crew should be planned to complete installation timely.
Consolidation of the slopes	Vegetated gabions stone are used to stabilise slopes, construct drop structures, pipe outlet structures or any other application where the soil must be protected from the erosive forces of water.
Remodelling of the land	Any large woody vegetation that has started to grow in the gabions should be removed and any damage to the gabions repaired. This may include replacing lost stone and repairing any damaged wire.

Key resources

Table 2.24 identifies the key resources needed to fulfil the proposition of the project.

Table 2.24: Key resources for vegetated gabions

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Key resources	Needed to/for…
Planners	Design of the surface
Government/Municipality	Realise the master plan and the surveys
Money and funds (EU, Municipality)	Design, implement and maintain the NBS
Marketing and advertising materials	UNaLab dissemination and communication
Privates	Maintenance of the surface

Cost structure

Table 2.25 summarises the main types of costs (estimated by the Municipality of Genoa) to be taken into account for the implementation and maintenance of vegetated gabions stones. All costs reported in the table include labour cost; costs for installation are included in manufacturing and implementation.

Table 2.25: Costs for the vegetated gabions

Type of costs	Cost for implementation
Manufacturing	60.000 €
Implementation	145 €/m3
Maintenance	1 €/m2 per year

2.4 Water sensitive urban design measures – Business Model examples

Water Sensitive Urban Design (WSUD) is an emerging urban development paradigm aimed to minimise hydrological impacts of urban development on the environment (Climate-ADAPT, 2016b). In practice, the WSDU integrates storm water, groundwater water supply and wastewater management to:

- protect existing natural features and ecological processes
- maintain natural hydrologic behaviour of catchments
- protect the water quality of surface and ground waters
- minimise demand on the reticulated water supply system
- minimise wastewater discharges to the natural environment
- integrate water into the landscape to enhance visual, social, cultural and ecological values.

Reducing hardened, impervious surfaces and accurately design drainage of urban spaces, in combination with the use of pervious roads, penetrable concrete and water passing pavements helps to enhance the infiltration of storm water in underlying surface, reducing runoff into sewerage systems and urban spaces, attenuating flood peaks, reducing the urban pollution load in run-off), as well as reduce the risk of damages due to drainage system failure by flooding.

Common WSUD practices are: bioswales, infiltration basins, detention ponds, retention ponds, rain gardens, bio filters, etc.

A **bioswale** is a vegetated, linear and low sloped pit often established in urban areas near/between roads with the objective to reduce flood risk during or after heavy rain events. The intention of bioswales is comparable to rain gardens. Bioswales absorb, store and convey surface water runoff (mainly draining from roadways) and also remove pollutants and sediments, when the water trickles through the vegetation and soil layer.

Dry detention ponds are surface storage basins that retain storm water. During periods of heavy rain, the area gets flooded and could lead to filling up of the detention pond in cases of longer duration of rainfall. After the rain ends, the water flows in the sewer system. If there is no event of heavy rainfall the detention ponds are dry and could be used as a green area. **Retention ponds** retain storm water continuously. In dry periods they also hold water.

A **rain garden** is a kind of garden that primarily serves as an area for water control (storage and infiltration) on a small-scale especially in urban areas. Storm water runoff is drained into rain gardens, where it is stored for a certain period, and infiltrates either into the ground soil or flows into the sewage system. A certain amount of water is taken up and transpired by plants.

Bio filters are developed to collect and purify storm- and wastewater and represent a promising system for storm water treatment. Bio filters separate/remove nutrients and organic carbons from wastewater/storm water through biodegradation. As a result bio filtration improves the quality of wastewater (reduction of nutrients, metals, sediments) and storm water and at the same time harvests storm water and stores it for a certain period.

Infiltration basins are flat areas planted with grass and normally dry. After heavy rain the water fills up the basin and soaks into the ground.

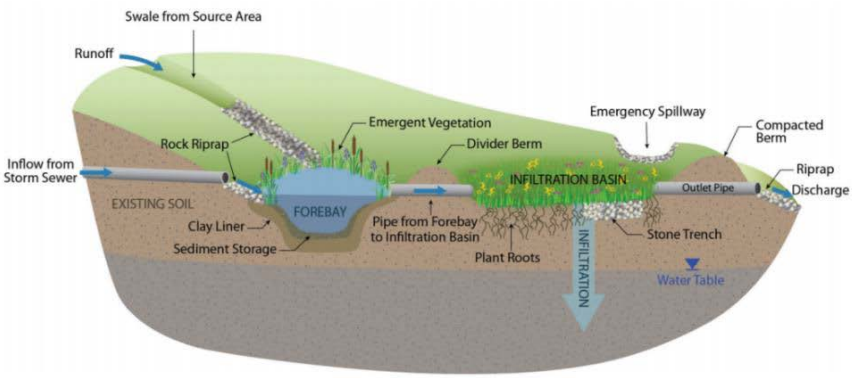


Figure 2.9: Example of Infiltration Basin[11]

The following *Table 2.26* resumes main features, value proposition, conditions for implementation, main stakeholders involved, costs, financing options and limits of Water Sensitive Urban Design measures, considering the desk research, the analysis of the NBS implemented in Front-runner Cities and information provided in the *D5.1 NSB Technical Handbook.*

Table 2.26: Features, value proposition, conditions for implementation, stakeholders, costs, financing options and limits of Water Sensitive Urban Design measures

Features
• Have to be lower than the ground level • Simple to construct • Basin should be flat (water has to soak equally) • Grass should be longer than 3 inches (otherwise it will not survive the flooding) • Infiltrate 50% of their storage volume within 24 hours of filling
Value proposition/Benefits

[11] Figure taken from the deliverable *D5.1 NBS Technical Handbook*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

- Remove pollution from the rainwater and improvement of water quality
- Storm water storage management and control
- Reduced flood risk
- Reduction of air pollution and urban heat island effect
- Habitat provision for wildlife
- Potentially re-use of water for irrigation
- Prevention of soil erosion
- Increased biodiversity and increased pollination of the flora
- Improved quality of life
- Visually aesthetic blue and green recreation and multiple use areas

Conditions for Implementation

- Available space
- Local soil conditions
- Highly specific rainwater intensities
- Can be integrated into personal gardens, parks, driveways
- Should not be directly connected with aquifers (even if there is a permeable layer in between)
- Enough space to get flooded

Limitations/Barriers

- Habitat provision limited on the ground level
- Limited design options
- Green space with too many functions → reduced recreation space

Stakeholders/Beneficiaries	Costs
• Inhabitants and citizens: people that live in the city will improve the quality of their life thanks to the enhancement of biodiversity, the reduction of heat stress and the establishment of social cohesion • Visitors and tourists, enjoying the new blue and green environment. • A municipality can finance the renovation. • Local businesses: the requalification of the area and the improvement of the quality of life within the city and the district may attract investments, commercial activities and other general businesses. • City users (e.g. employees and students): people that do not necessarily live in the city but come regularly to the city for work or to use other services or amenities could benefit from the requalification of the area	Costs vary depending on size, site conditions and the type and size of the vegetation used. In particular, annual maintenance costs include necessary pruning, mowing of the vegetation existing in the park, periodical cleaning of the park and control of inlet and outlet structures, enabling water flow management in the detention basin. • Manufacturing ≈ 26.000 € • Implementation ≈ 235 €/m2 • Maintenance ≈ 0,5 €/m2 per year • Storm water management system) ≈ 200 000 €-700 000 € according to the systems installed, for example: o Biofilter ≈ 50 000 € o The retention pond and alluvial meadow ≈ 50 000 € o Urban gardening ≈ 30 000 € • Planning ≈ 10 000 € In a previous project in London, the total cost for the design and construction of rain gardens and swales amounted under 40 000 €.

• Facilitation group composed by representatives from the main municipal departments • Steering group composed by project partners and funders from different departments and research institutes	

Financing options

- Innovative municipal financing approaches
  - Municipal investment: municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance. For example innovation vouchers used in Tampere enable existing housing companies and other communities to co-design and co-implement NBS and complementary infrastructure and/or urban garden areas
  - Accessing external funding sources: for example regional, national and EU and/or other funds can be an important source of NBS financing
- Public-Private partnerships
  - Contractual PPPs: standard contracts with the private sector for the NBS maintenance
  - Institutionalised PPPs: the establishment of an institutionalised PPP can be done either through an entity where public and private sectors jointly participate or through private sector buying and owning shares in an existing public company
  - Partnerships encouraged by external funding programmes (e.g. EU funding): public-private cooperation concept developed as part of the donor-funded project
- Mandatory Requirements and Tax Initiatives
  - Private sector financing: private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems. For example, housing companies and other communities can provide resources because of their interest in the selected NBS.
  - Storm water fee: Storm water fees are imposed on property owners based on the storm water run-off from the impervious surfaces that need to be accommodated in the storm water drainage system. For example, Tampere introduced a storm water fee, which should contribute to municipal expenses for the provision, management and maintenance of the water and sewage system.
- Incentive programmes
  - Private sector financing: private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems. For example, housing companies and other communities can provide resources because of their interest in the selected NBS.
  - Storm water retention credits: cities may create “stormwater credit trading” programs, which allow developers to meet their stormwater retention requirements on their own sites or elect to purchase “credits” for stormwater retention from others who have voluntarily retrofitted their properties through a storm water credit-trading program
  - Crowd-funding / sponsorship: a large number of people contributes to NBS development with a relatively small amount of money.

European Commission
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

2.4.1 Case studies of water sensitive urban design measures beyond UNaLab

An example of water sensitive urban design measure is the infiltration basin. A case study of its implementation is the **Queen Mary's Walk, Llanelli** (Susdrain), a project related to planted basins and swales (Susdrain, n.d).

The project aims to reduce flows and attenuate flows during storm events, by means of Sustainable Drainage Systems (SuDS) with the following characteristics:

- 100m long planted swale with 150mm perforated pipe in the playing field adjacent to Queen Mary's Walk;
- Planted basin forming part of the highways drainage.

As a result of this scheme, the peak flow rate of surface water runoff entering the public sewer network has been drastically reduced.

Maintenance will be undertaken by an agreement with the local authority.

The main stakeholders involved in the modelling of this project is a water and sewerage company. In addition, in order to ensure effective communication with the local authority, a facilitation group has been established. The group is made up of representatives from multiple departments and includes legal, planning, asset strategy, biodiversity, land drainage, communications, capital delivery, design, street works, highways and land agents.

Another example of this kind of NBS is the project referring to the **Houndsden Road Rain Gardens in London** (Susdrain, n.d). The project consists in the creation of rain gardens and swales to improve the water quality, treating pollution and preventing oils and heavy metals washing into the Houndsden Gutter.

The success of this project is linked to the creation of some strategic partnerships. In particular, a steering group was formed: project partners and funders were the London Borough of Enfield (LBE), the Environment Agency giving advice and support and others funders. A Structures and Watercourses team, along with others provided a broad scope of experience and knowledge, guiding the process of planning and design, and helping with issues encountered in the implementation of the initial sites. In addition, support from numerous council departments was forthcoming, especially Parks and Highways.

The total cost for the design and construction of the project amounted under 40 000 €.

2.4.2 The business model of Infiltration Basins in Genoa

Infiltration basins are smooth depressions planted with grass and normally dry. After a heavy rainfall event, water flowing from uphill runoff might fill up the basin and gradually soaks into the ground.

The objective of the implementation of infiltration basins in the city of Genoa is the management of runoff water coming from the slopes and pathways relative to the Cinque Santi River and their infiltration into the soil.

As the other NBS selected by Genoa, the infiltration basins will be implemented in the area of the Gavoglio Barracks.

Value proposition

Since the city of Genoa faces numerous environmental challenges relating to extreme weather conditions, water management issues, heat stress and water and air pollution, the implementation of infiltration basins allow increasing the environmental benefits **removing pollution from the rainwater** by settling and filtering out pollutants. Such NBS allows also refilling groundwater and can provide **storm-water storage capacity** in a large drainage area.

Furthermore, infiltration basins will also allow fulfilling other specific needs of the neighbourhood such as the **reduction of air pollution and urban heat island effect** thanks to the implemented green areas, which will increase the absorption of CO_2.

The **vegetation** planted on infiltration basins also helps to **prevent soil erosion**, provides **wildlife habitat** and **increases pollination of the flora**, thus increasing local **biodiversity**.

The green area will also improve the **attractiveness** of the district as well as the **quality of life** of inhabitants of such a socially deprived area.

Other additional benefits expected are:

- retaining **runoff water and rain water recovery for irrigation**;
- creation of an attractive pole within the city and the district that may **attract investments, commercial activities and other general businesses**.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are very similar to those relevant for the previous NBS because all NBS selected by the Municipality of Genoa will be implemented in the same area. In summary, they are:

- Inhabitants and citizens: people that live in the city and, in particular, near to the Cinque Santi River will benefit the rainwater management resulting in a better quality of life in a poor area.
- Municipality: the Municipality of Genoa owns the area and finances its renovation
- Local businesses: the requalification of the area and the improvement of the quality of life within the city and the district may attract investments, commercial activities and other general businesses.

Financing models

As for the other Genoa's selected NBS, the planned interventions need public funds for their realisation. However, private sponsors (e.g. shops near the selected area), with the support of citizens' associations could be involved especially for the maintenance of the NBS.

Actors involved in the implementation and maintenance of infiltration basins

The following actors will be involved in NBS implementation and maintenance of the selected NBS:

- Municipality of Genoa
- Liguria Region
- Citizens and local/voluntary associations
- University of Genoa
- Business associations (engineers, architects, biologists)
- Tenants of buildings nearby the area (e.g. B&B, social services, student rooms)

Key activities

The following *Table 2.27* identifies the key activities needed to deliver the proposition of the infiltration basins.

Table 2.27: Key activities foreseen for the implementation of the infiltration basins

Key activities	Description

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Hydraulic survey	Specific analysis on the ground water table, ground water fluctuations, permeability analysis of the soil
Periodic maintenance	Maintenance of the surface can be performed periodically and after major storm events. Maintenance needs to include removing sediment and debris, cleaning and repairing inlets, embankments, berms, dams, and outlets as needed, erosion control and proper drainage.
Green cover	Infiltration basins can be planted with a variety of grasses. Trees can be planted on the border of such basins, thus contributing to water absorption and local temperature reduction.
Implementation	The realisation of the new area

Key resources

The following *Table 2.28* identifies key resources needed to fulfil the proposition of the infiltration basins.

Table 2.28: Key resources for infiltration basins

Key resources	Needed to/for…
Planners	Design of surfaces
Government/Municipality	Realise the master plan and the surveys
Money and funds (EU, Municipality)	Design, implement and maintain the NBS
Marketing and advertising materials	UNaLab dissemination and communication
Privates	Maintenance of the surface

Cost structure

This section collects the preliminary information about the main economic costs needed for the implementation of infiltration basins in the renovation works of the area.
Table 2.29 summarises the main types of cost to be taken into account for the implementation and maintenance of infiltration basins, as estimated by the Municipality of Genoa. All costs reported in the table include labour cost; costs for installation are included in manufacturing and implementation.

Table 2.29: Costs for the infiltration basins

Type of costs	Cost for implementation
Manufacturing	26.000 €
Implementation	235 €/m2 (97€/m3)
Maintenance	0,5 €/m2 per year

Costs for the implementation of vegetated infiltration basins varies depending on size, site conditions, and the type and size of the vegetation used. In particular, annual maintenance costs include necessary pruning, mowing of the vegetation existing in the park, periodical cleaning of the park and control of inlet and outlet structures, enabling water flow management in the detention basin.

2.4.3 The business model of Storm Water System (Bio Filter, Retentions Basins, Alluvial Meadow) in Vuores (Tampere)

The storm water management system to be installed in Vuores will be a hybrid system characterised by some blocks that gather and manage storm water sewers. This system will be one of the largest storm water systems in Nordic countries. There are plot- and block-specific methods for handling of storm water before it enters the storm water sewers in the streets and finally to NBS in public areas.

At the moment (2018) NBS in public areas consists of 7 bios wales, 10 retention ponds, 3 wetlands, willow treatment, alluvial meadows and a bio filtration system. The bio filter will be installed in Virolaisten Park (area of ca. 650 m2) while the retention/infiltration basin with alluvial meadows will be installed in Tervaslammen Park (area of ca. 700 m2).

Value proposition

The storm water system is a multi-functional green infrastructure whose main objective is the **storm water management** in order **to prevent solids and nutrient load to waterways, handle the first flush, prevent urban floods, maintain moisture conditions, retain and increase biodiversity** and regulate flow rates to the pre-construction level by drainage area.
In addition, it aims to **enhance social cohesion** developing **visually aesthetic blue and green recreation and multiple use areas,** where people meet and recreate.
This solution can improve **biodiversity, water and air quality by** providing attractive green and healthy areas for citizens.

Key Beneficiaries and Stakeholders

The main groups of beneficiaries are:

- Inhabitants and citizens: people that live in the Vuores area will improve the quality of their life thanks to the enhancement of biodiversity, the reduction of heat stress and the establishment of social cohesion. In particular, the availability of blue and green areas will be beneficial especially for families and people enjoying open air sports.
- City users (e.g. employees and students): people that do not live in the city but come regularly in the city for work or to use other services or amenities could benefit of the requalification of the area.
- Visitors and tourists, enjoying the new blue and green environment.
- Municipality: the Municipality of Tampere owns the Vuores area and finance the renovation

Financing models

According to a first estimation coming from the Municipality of Tampere, the Vuores storm water management is mainly funded with public money from the municipality, and in particular, form taxes, state grants and customer fees. There was a Vuores development program from 2002 to 2016 and it had an own budget for developing the area.

In addition, private investors have financed block- and plot-specific storm water management.

As for urban gardens, a bio filter small-scale NBS will be funded via innovation vouchers to enable existing housing companies and other communities to co-design and co-implement NBS and complementary infrastructure and/or urban garden areas. Through the use of innovation vouchers, housing companies and other communities in Vuores can apply for 3 x 10 000 € vouchers to plan and implement communal gardens, which improve storm water management, biodiversity and recreational use of gardens. Housing companies and other communities finance the rest of the implementation not covered by innovation vouchers.

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

From 2018, a storm water fee (amounting in total 5,6 million €/year)[12] was introduced targeting the storm water management and contributes to the funding of the implementation and maintenance of the selected NBS.

In general, multi-functional NBS focusing on storm water management are funded by the public budget. In addition, housing companies provided resources, because of their interest in the building of a large storm water management system.

Actors involved in the implementation and maintenance of re-establishment of the storm water system

In order to achieve a good implementation of the NBS in Tampere, public and private stakeholders have been widely involved. The main actors involved in the implementation and maintenance of storm water systems are reported below:

- Storm water planners are involved in the planning of the storm water system
- Landscape architects are involved in the design of the area
- Ramboll is involved in the project with the role of green expert, stakeholder engagement and project management duties. The main activities performed are related to the planning stage
- Construction, maintenance and environmental protection departments are involved in the construction and maintenance of the green infrastructure and environmental protection
- Citizens (co-creation participants, residents, Vuores visitors, students, NGOs) are involved in the co-creation, testing and possibly maintenance and monitoring of the solution. The main activities performed are the participation in UNaLab and other co-creation activities, site visits to the demo site, changing knowledge and iterating plans

Key activities

The following *Table 2.30* identifies the key activities needed to implement the storm water system and reach the aim of the project.

Table 2.30: Key activities foreseen for the implementation of the storm water system

Key activities	Description
R&D	Consulting previous R&D projects, setting monitoring program according to the aims, analysing results, mobilising results (e.g. water management, biodiversity, carbon storage, recreation).
Treatment of water	Treatment of waters from the Vuores area including construction work areas (e.g. retention and filtration). Treatment in plots and in public areas.
Planning and building	Planning and realisation of the new area
Maintenance	Learning new maintenance practices that again meet the aims, new actors are needed, and heavy maintenance may not be feasible. Maintenance of multi-functional NBS requires co-operation between sectors and city units.
Workshops and online surveys	Information sharing through active stakeholder participation in co-creation workshop and online surveys

[12] Figures from Municipality of Tampere

Recreation and Education	Multi-functional NBS are expected to enhance recreational values. NBS knowledge is increased via co-creation, signs, web, involving school kids. Information towards stakeholders is crucial.
Accessibility	Path network around the NBS is improved

Key resources

Table 2.31 identifies the key resources needed to fulfil the proposition of the project.

Table 2.31: Key resources for storm water system

Key resources	Needed to/for…
Planners and builders	Implement and maintain the storm water system in the Vuores area
Money and funds (EU + municipality)	The construction phase by companies/investors
Marketing and advertising materials	Involve stakeholders and mobilise results

Cost structure

Table 2.32 summarises the costs for the implementation of the selected NBS, preliminarily estimated by the Municipality of Tampere.

Table 2.32: Costs for the implementation of the storm water system

Type of costs	Cost for implementation
Central Park storm water management system (retention bonds, bioswales, submerged dams, meandering stream, alluvial meadows)	760 000 €
Tuomisto park storm water management system (bioswale, retention pond, submerged dam, wetland)	122 000 €
Hupankankorpi storm water management system (retention ponds)	131 000 €
Planning	ca. 10 000 €
Construction and materials	E.g. for a bio filter ca. 50 000 €, for a retention pond and alluvial meadow ca. 50 000 €, for urban gardening and other similar solutions ca. 30 000 €
Maintenance	To be determined

2.5 Main findings: NBS business models

From the analysis of the above business models, we can observe that the NBS selected by each Front-runner City have an impact on different NBS categories considered in the framework of the *D5.1 NSB Technical Handbook.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

In fact, in most cases Front-runners' business models offer several **interesting solutions of high replication and upscaling potential** in other cities or contexts. For instance, the "innovation vouchers" used by Tampere to enable existing housing companies and other communities to co-design and co-implement small-scale NBS in urban garden areas are replicable in other cities and/or for other contexts where small-medium size NBS are applied (e.g. green roofs and vertical green). The co-sharing of responsibilities and costs between the "Water Board" and municipality of Eindhoven is essential in daylighting of river "Gender", because of the impact on the NBS on the water infrastructure. Similar involvement of municipalities' utilities may be considered when the implementation of NBS (infiltration basins, permeable pavements, bio-filters, alluvial meadows etc.) have a positive impact on the water management system, by decreasing the risk of flooding, improving the water quality, creating storm water storage etc. Finally, the engagement of voluntary citizen associations in the maintenance activities, as foreseen for Genova's NBS dedicated to permeable surfaces and green urban areas, can be replicable in many contexts where NBS contribute to the requalification of derelict areas, which might be the focus of charities and volunteer associations working on socially deprived areas.

As previously mentioned, a replication assessment of the NBS implemented by Front-runner Cities will be provided in the later stage of the project, when details on implementation actual costs and first monitoring data on Front-runner NBS become available. Such analysis will be included in D6.8 "Handbook to Support NBS Implementation" (M60).

The "**Canvas Business Model" was an easy and effective tool to engage the Front-runner Cities' municipalities** in the business model analysis of their NBS. Enlarging the analysis to NBS implemented in other projects favoured the generalisation of business models and provided more examples of possible financing options for the same NBS categories. However, some **limitations** of the adoption of the Canvas Business Models also arise: first of all, the methodology is highly dependent on the type of stakeholders and experts involved in the analysis. In fact, municipality representatives might be the optimal stakeholders to highlight the social and environmental value of the NBS but sometimes they may fail to identify the direct and indirect benefits for the private sector. Therefore, as done within UNaLab Front-runner Cities, it is essential to involve in such analysis private and public stakeholders beyond the municipalities, through for example co-creation sessions.

On the other hand, it is also true that in some cases, it is very difficult to capture the NBS direct value for the private sector, especially when the social and environmental benefits are difficult to quantify: other methodologies and approaches may apply, as discussed in the *D6.4 NBS Value Model*. In this respect, it is also important to mention that the Community of Practice (CoP) on Finance@Biodiversity of the Business@Biodiversity European Platform, which includes 13 financial institutions. In 2018 they provided recommendations for biodiversity accounting, such as *Common Ground in biodiversity footprint methodologies for the financial sector* and *Assessment of biodiversity accounting approaches for businesses and financial institutions* for policy makers, developers and financial institutions.

Finally, the business model analysis provided in this chapter included non-exhaustive lists of possible examples of financing options for each of the selected NBS categories. A comprehensive framework of NBS financing strategies, suitable also for NBS categories not implemented in UNaLab is provided in the subsequent chapter.

3. FINANCING STRATEGIES FOR NBS

3.1 Overview of the financing strategies for NBS

To determine the financing strategies for NBS, a literature review including academic and grey literature has been performed identifying ~30 financial arrangements and mechanisms that could be used to finance NBS. This review has focused on the literature that would inform on potential municipal finance innovation pathways, ranging from attracting additional capital investments for public projects to encouraging private sector implementation of NBS.

The analysis of the ~30 identified financial mechanisms has suggested their distinction into five broad groups. Based on the role of the municipality and the nature of its interaction with the private sector the following groups, which are discussed in the next sub-chapters, have been distinguished:

- *3.1.3.Innovative municipal finance approaches* describe the financing strategy where a municipality is primarily responsible for financing NBS, however, a range of alternative options of raising funds for NBS projects and programmes are explored including cross-departmental funding, institutional investors, external funding, etc.
- *3.1.4.Public-Private Partnerships* describes the setting in which city administration forms partnerships with the private sector. The responsibility and risks for NBS financing, implementation and maintenance are shared between public and private partners.
- *3.1.5.Mandatory Requirements and Tax Initiatives* describes the strategy where NBS implementation is "pushed" by city administrations by issuing mandatory requirements and taxes/fees for private entities. NBS is implemented either by the private entities in order to comply with these requirements or by public agencies through tax revenues (provided the tax revenue ring-fencing mechanisms are in place).
- *3.1.6 Incentive programmes* describe the setting in which economic and regulatory incentives and frameworks are offered as "pull" factors to enable bottom-up implementation of NBS by private entities.
- *3.1.7 Municipal Funds* describes a strategy where the municipality designs a financial scheme to promote private sector investments in NBS by offering loans. Even though this category resembles *3.1.6* by offering financial incentives, it encompasses a different set of features and risks.

The grouping exercise was performed in order to derive the overarching financing strategies the municipalities could consider on a strategic, city level. The following chapters include a brief description of the main features of the groups, associated risks, and potential advantages and disadvantages. Please note that the groups are not necessarily mutually exclusive and their features might be combined.

Subsequently, each of the four groups consists of a number of financial options that could be introduced when implementing individual projects or project clusters. These options could be found in the *Examples of financing options* sub-chapters for each financing strategy. While this distinction between strategic, city-level financing strategies and particular project-oriented financing options has proven useful for the UNaLab project deliverables and activities (e.g. *D6.4 NBS Value Model, Roadmapping workshops, D.6.2 Municipal Governance Guidelines*

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

(D6.2 focuses explicitly on the city level guidelines)), certain overlaps between the two levels might exist in reality and thus each of the proposed strategies and options need to be critically reviewed in the context of specific cities.

These financing options have been used by the experts of Fraunhofer IAO and RINA Consulting to identify the underlying financing models for the different types of NBS that are discussed in *2.UNaLab Business Models.* In addition, some of the identified financing options have been used in *D6.4 NBS Value Model* and during the concept development phase of the *Roadmapping workshops.* The identified financing options might prove useful for the cities outside of the UNaLab project as well as provide further inspiration and input for the UNaLab activities (e.g. further *NBS Value Model* tool development).

3.1.1 Conceptual framework

The public-private sector interactions across the five groups have been investigated following a conceptual framework whose variations are reflected in *Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4 and Figure 3.5*

In the simplified setting of this report, the municipality is perceived as the key agent, who has the power to introduce different financial and/or regulatory mechanisms that would catalyse investments in NBS. To introduce the different financial tools, the municipality might allocate funds from the public budget (which in turn could be enhanced by the EU and/or other donor funding, cross-departmental cooperation etc.) or source the capital from the private sector investors (e.g. institutional, impact investors).This interaction is mediated by the commercial banks that would serve the role of issuer and verifier.

Once sufficient resources are available, municipalities could either finance NBS themselves, or initiate different tools to promote investments in NBS. The identified tools could be observed as green rhombus shapes in *Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4 and Figure 3.5*. Furthermore, leveraging private investments does not necessarily imply having financial resources flowing through or from the municipality. The regulatory role of a city might also create incentives or enforcements for private actors to disburse money directly to projects and policies.

The introduction of the financial and/or regulatory tools encourages the implementation of NBS, which in turn yield a range of returns. Some of the NBS returns could be directly enjoyed by the beneficiaries of the projects and/or the financial mechanisms (e.g. monetary savings potential, increased aesthetic value). The municipalities might enjoy financial returns from NBS projects too (e.g. savings from the reduced storm water run-off mitigation efforts and/or extreme flooding events). However, NBS also tend to have a range of public environmental and social benefits. The NBS returns are often perceived as intangible goods. Thus, the “return” arrows in the figures do not always point to particular beneficiaries, but rather aim to illustrate wider financial and non-financial returns enjoyed by both public and private stakeholders. These potential benefits of NBS are highlighted in the “Value proposition” chapters of the *2.UNaLab Business Models.*

3.1.2 Underlying assumptions

This section assumes that, in general, municipal administrations already have the competences to plan, finance and implement infrastructure projects through traditional approaches, where the city is solely responsible for planning, designing, financing, building, maintaining and operating the project.

In contrast, the adoption of alternative financial strategies that encourage the participation of private sector in sharing costs and gains, risks and benefits, encompasses additional

uncertainties for the cities. Many cities might have limited experience in dealing with such uncertainties and risks. Therefore, they need to be thoroughly investigated before a respective financing strategy is put into practice.

Furthermore, the design of an alternative financial strategy is also highly dependent on the local context. Such factors as the technical characteristics of NBS, the regulatory frameworks, the availability, capability and interest of private sector to participate in NBS projects, the financial and technical capacity of the city, as well as the political and social support, are likely to determine the choice between different financing alternatives for NBS.

In addition, the public and intangible nature of many of the NBS benefits contributes to the uncertainty that cities have to deal with when trying to design the financing strategies for these interventions. Often NBS projects might lack a well-defined revenue stream, might differ substantially in the scale of implementation and thus their up-scaling might be difficult in terms of size and/or potential to generate revenues.

3.1.3 Innovative municipal financing approaches

Since NBS interventions deliver public goods and are often implemented on public land and/or buildings, the municipal budget allocations are often expected to constitute the majority of NBS funding and financing. Thus innovation in the municipal financing practices has the potential to expand the available capital base and thus facilitate the NBS implementation. Examples, of such schemes refer to issuing green bonds, fostering cross-departmental financing of NBS and securing funds from external sources (e.g. EU or other funding programmes). These instruments can be combined.

Municipalities can secure additional funds for NBS implementation by issuing green bonds. Green bonds that earmark proceeds to green projects might be especially suited for long-term, large-scale and capital-intensive projects, where attracting broader and more attached investor base (e.g., institutional investors, such as pension funds) might be crucial for the successful implementation (Climate Bonds Initiative, n.d.).To make the green municipal bonds more feasible and attractive to the potential investors, cities might consider clustering similar, urban sustainability-enhancing projects. Issuing green bonds calls for identifying the qualifying assets and projects, seeking an independent review from a certified verifier, and setting up tracking and reporting frameworks for the use of proceeds (Climate Bonds Initiative, n.d).As NBS have the potential to deliver a range of benefits with a positive environmental impact, green bonds might be used to attract investors with an impact investment focus.

In addition, local governments might expand the pool of available funding for NBS by coordinating funding across the budgets of multiple municipal departments. This coordination has the potential to enable cost sharing across the budgets of different municipal departments. This could include the coordination among the departments of transportation, sanitation, green spaces, water management, housing and urban development, and energy (the United States Environmental Protection Agency, n.d.). However, involving other municipal departments might yield additional benefits. Examples of departments to be involved with NBS financing might include water, urban planning, transport, social development departments and health agencies.

Lastly, to boost the NBS funding, municipalities can explore opportunities for participating in EU or other donor-funded programmes. Since NBS provide multi-sectorial benefits, such projects have the potential to be funded by programmes and calls focused on climate change adaptation, urban and rural resilience, biodiversity, ecosystem enhancement, etc. However, to

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

be successful the projects need to meet the eligibility criteria (these can include the size of the project, type of technology and partnerships needed, bankability of the project, etc.).

Overall, following this financing strategy would imply that the municipality is in the lead of implementing NBS projects, yet it secures the funds from a broader spectrum of sources rather than relying primarily on central government transfers or internal revenues. A simplified depiction of this category of such municipal financing schemes could be observed in *Figure 3.1*

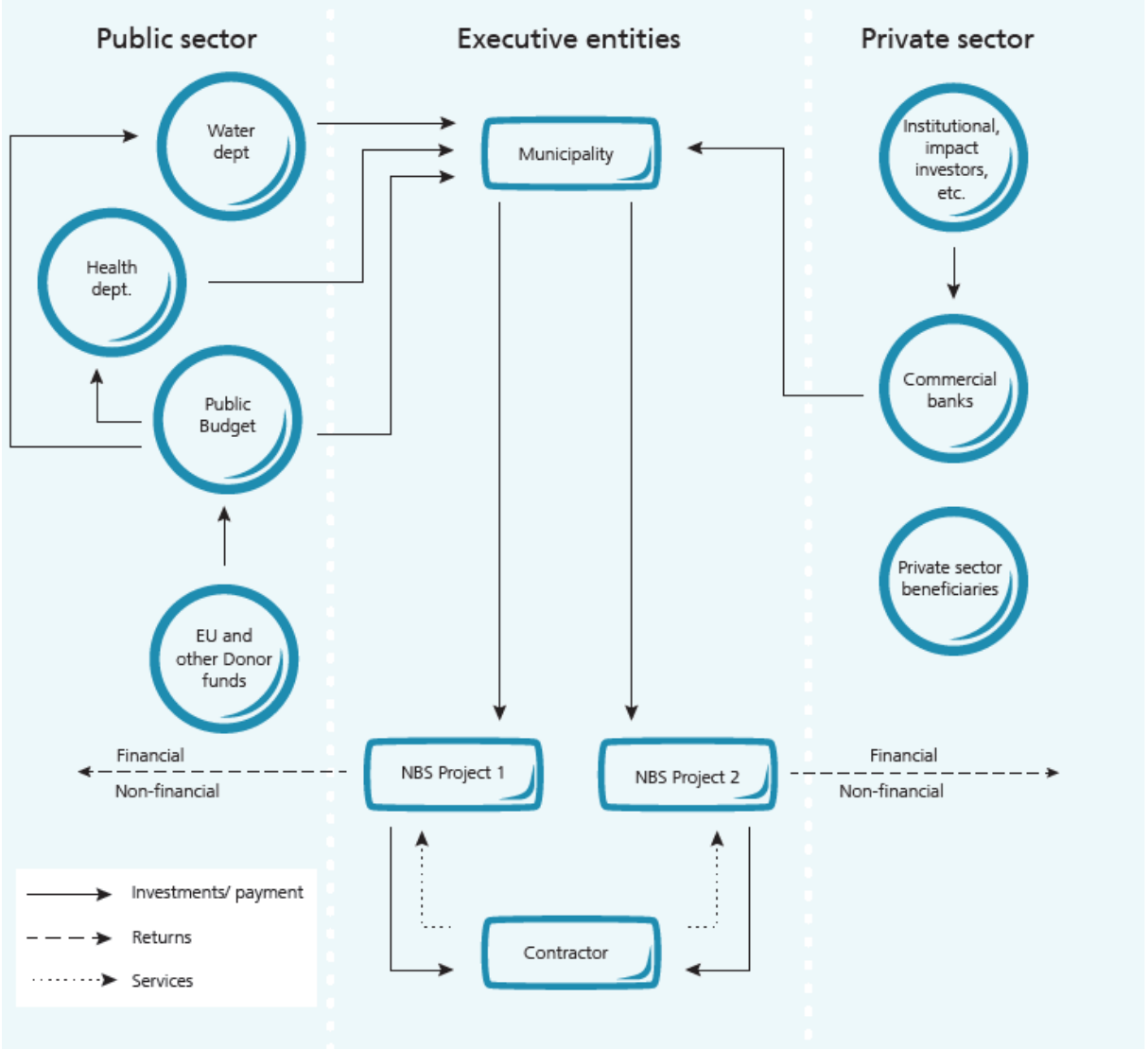


Figure 3.1: Innovative municipal financing approaches

Associated risks

- The small number of viable projects or insufficient scale of the projects to demonstrate impact and thus attract investors and/or qualify for external funding programmes
- The reputational risk for green bonds issuers, i.e. when bonds labelled as "green" do not fulfil the "green" criteria, remain high and can have an impact on investors' trust (UNDP, n.d.)
- Uncertainties related to the technical and operational challenges of the interventions and the extent and nature of the delivered benefits (Weisbord & Orlowski, n.d.).
- High transaction costs of engaging with debt-based financial instruments and/or promoting the partnerships within (cross-departmental) and outside (between cities,

with the private sector, etc.) might make more traditional sources of capital more attractive.

- Political risk. The political priorities of the local or national government might shift and municipal finance schemes may fall short of the resources and partnerships needed for their operation.

Potential advantages and disadvantages

Engaging in innovative financial borrowing schemes, such as green bonds, allows the municipalities to tap into much wider investor base that typically includes institutional investors, specifically pension funds and insurance companies as well as banks and investment funds (GIZ, 2018). Having secured additional capital, the municipalities can support NBS projects that would experience difficulties in accessing capital from other sources (e.g. due to the size of the project, limited bankability of the project, etc.).

However, in some cases the regulatory frameworks might restrict the extent to which municipalities can engage in such initiatives (e.g. cities might not be able to issue bonds). It might also require substantial labour and time investments from the municipality. Lastly, coordination among municipal departments to secure cross-departmental funding might prove challenging in case the larger political objectives are not aligned within the municipality. Also, better coordination across departments could potentially reduce the costs for implementation of NBS. For example, the implementation of permeable surfaces could be matched with the timing of other street reconstruction projects (Georgetown Climate Center, n.d.).

Examples of innovative municipal finance approaches

Table 3.1: Examples of Financing Options

Financing option	Short description
Green bonds	Green bonds are similar to regular bonds, the difference is that the capital raised by green bonds is used for projects with positive environmental outcomes. The revenues for green bonds can be achieved through various means ranging from public budget allocations to market returns.
Example: San Francisco Public Utilities Commission has issued a Water Infrastructure Bond certified under the Climate Bonds Standard. Proceeds from this bond will fund eligible projects in sustainable storm water management and wastewater projects (Climate Bonds Initiative, n.d.)	
Cross-departmental budget	NBS financing could be enhanced by promoting the communication, cooperation and cost sharing across the budgets of different municipal departments or cross-departmental budgets for the multidisciplinary interventions.
Example: Herron Park in Philadelphia has been reconstructed from a largely concrete covered area to an urban park with recreational amenities and stormwater management elements. The Philadelphia Recreation Department and the Philadelphia Water Department have funded this project in relation to the municipal strategy adopted by the city for implementing the improvements in stormwater management and water quality in local streams and rivers. This approach focused on using green infrastructure to change the city's drainage and provide	

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

other benefits to the local community (Environmental Protection Agency of The United States of America [EPA], 2017b),	
Municipal investment	A traditional top-down approach where municipality takes the lead in NBS financing by earmarking a share of public budget for the NBS implementation and maintenance.
Example: Alna Environmental Park in Oslo is a part of a large scale river day-lighting project led by the Oslo municipality. The Environmental Park is foreseen to run along the river Alna and transform grey infrastructure to accessible parks and recreation areas. The project is funded by the Oslo municipality in combination with national government transfers (Naturvation, n.d.)	
Accessing external funding sources	External financing sources obtained through the EU and/or other funds and financing facilities can be an important source of NBS financing. The listed funding programmes are examples of some of the most relevant contemporary financing possibilities made available to the cities
Example: The city of Craiova in Romania has received a 15 million EUR long-term loan from EBRD to finance key urban projects in the city, which include the implementation of the green infrastructure. Under this programme, the EBRD will support the city of Craiova with developing a Green City Action plan which will look at ways to improve the urban environment, as well as invest in greener transport, water and waste management (Rosca, 2018).	

3.1.4 Public-Private Partnerships

Public-Private Partnership (PPP) is an umbrella concept to define different modalities of "long-term contract(s) between a private party and a government (public) entity, for providing a public asset or service, in which the private party bears the significant risk and management responsibility and remuneration is linked to performance" (The World Bank, 2017). An alternative PPP definition regards PPP “as the cooperation (risk and benefit sharing) of business entities with public actors, even when these business entities are not specializing in this field” (Green Surge, p.37). This report considers for both definitions of PPPs to account for formalised, contractual agreements between public and private entities, as well as less-standard combinations of public and private sector cooperation. In some cases, PPPs might also involve NGOs, who would serve the function of a discussion partner, to build capacity or act as co-designer for green standards. (Hospes, Dewulf, & Faling, 2016).

The types of PPP vary according to three basic parameters (The World Bank, 2017):

- **Type of asset:** PPP contracts require different arrangements depending on whether the object of the contract is new or existing assets (e.g. construction of a new park or retrofit of an existing one);
- **Distribution of functions among public and private partners:** depending on the specific characteristics of each project, private actors can perform functions such as designing, building/rehabilitating, financing, maintaining, operating etc.;
- **Payment mechanism:** Remuneration of private services can range from being entirely funded by the government to entirely funded by service users, as well as different combinations of payment sources between these two ends.

In all different PPP arrangements, public resources intertwine with private ones. For this reason, the inclusion of external, independent observers to guarantee the legality of the contracts and of the financial transactions, especially once operations begin, is recommended.

The financing of PPPs could be reinforced by creating a new institutional entity called the Special Purpose Vehicle (SPV). Established by blending public and private funds, SPV conducts the construction and operation of the project, with its own budget and distribution of costs, expenses and revenues according to the respective contributions and risks are taken by each of the participating institutions. In most cases, at least part of the capital investment for the SPV will have to be obtained by the partners from financial institutions (e.g. public, private or international organisations). To simplify this complex scheme, *Figure 3.2* shows the entanglement between financing sources and private parties as well as government entities, that where mentioned above.

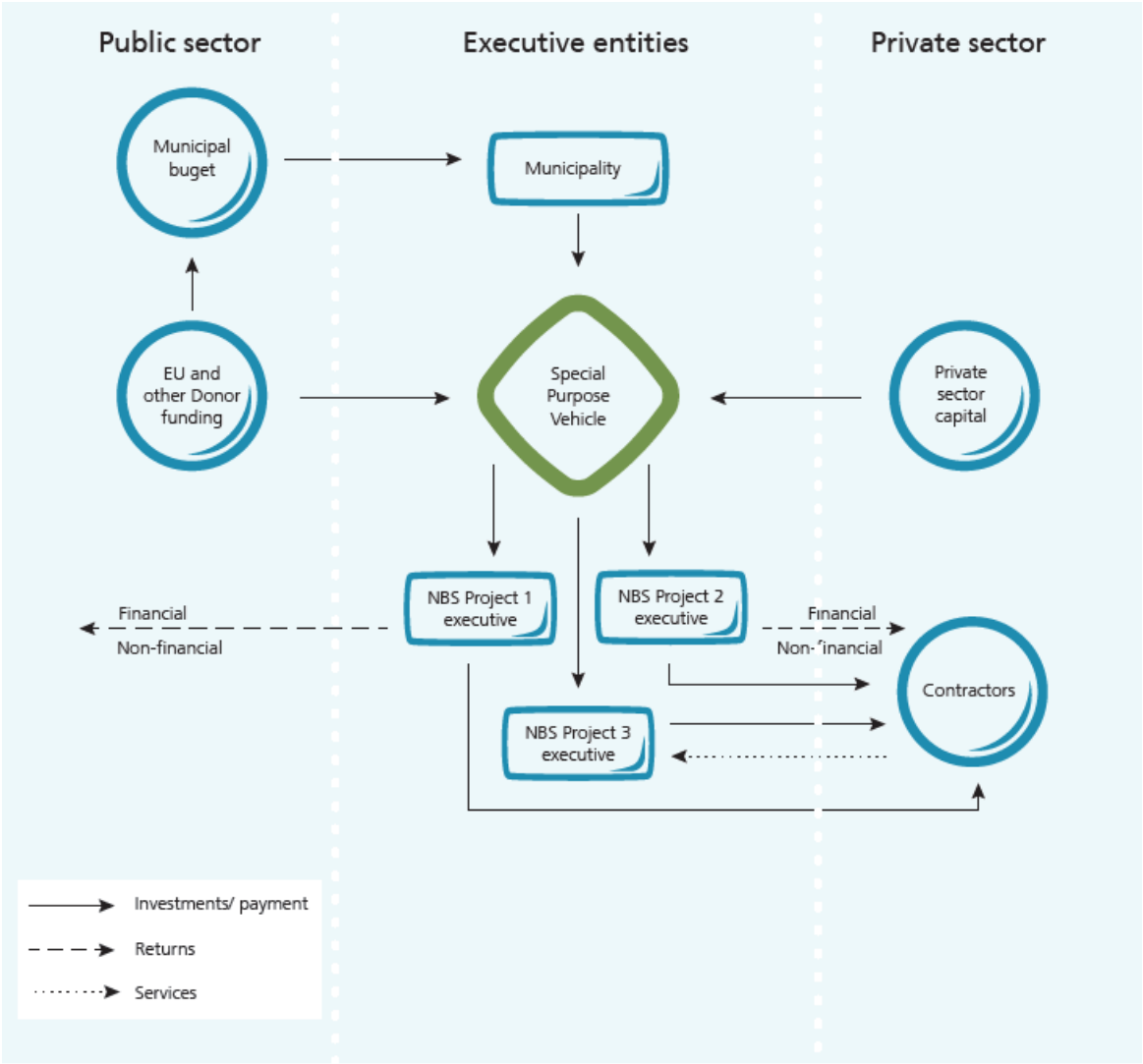


Figure 3.2: Public-Private Partnerships

Figure 3.2 shows the interaction between financing sources and executive entities (public and private) which together inform long-term projects

Associated risks

Project developers must be able to identify risks and mitigation options, and to define how to allocate them, i.e. which partners are better prepared to address which kinds of risks. According to the World Bank, there are several risk categories associated with PPPs:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

- Construction and Completion Risks are the difference between planned and actual costs of construction, as well as delays and qualitative performance issues of the delivered project.
- Operating Risks, including changes in the costs of inputs (energy, water), salaries and operational performance.
- Force Majeure is external, unforeseeable and unavoidable events, which render the execution of the work impossible, and change in regulation.
- Environmental Risk, or the risk of non-compliance with environmental regulations and standards set either by national laws or international financial institutions can be a problem.
- Social Risk, relating both to the risks caused by impacts of construction and operation on local populations, or on society and users, need to be mitigated as well (Public-Private Partnership Legal Resource Center, n.d.).

Potential advantages and disadvantages

Well-designed PPPs can combine the advantages of both public and private investments in a single project. Private know-how and flexibility can provide projects with superior efficiency, in terms of financing, construction, maintenance and operation quality and cost. In addition, the allocation of financial risks can be more efficiently shared among the partners involved, according to their profiles and roles in the partnership. If contractual arrangements are appropriately done, PPP investments can combine the representation of the public interest (affordable costs for end users, observance of labour and environmental standards, and generation of positive social and environmental externalities) with the efficiency-seeking motivation of the private sector. (APMG International, 2018). Especially big NBS projects, such as urban parks or water retention ponds can benefit from PPPs as these projects have a higher potential to deliver the desired impact at scale.

The clearest disadvantage of PPPs is its inherent complexity. Because it involves long-term contracts between two or more entities of different legal nature, the procurement process has to be conducted with great care and requires significant technical capacity from the public institution to plan, procure, contract, execute and monitor all planned activities. It also requires a long-term commitment from the parties involved.

The common reasons for the failure of PPPs include (Cuttaree, 2008)

- Poor legal framework and enforcement
- Weak institutional capacity and PPP strategy
- Unrealistic revenue and cost estimations
- Lack of thorough financial and economic analysis
- Inappropriate sharing of risks
- Lack of competitive procurement
- Public resistance to paying for services

Examples of different types of PPPs

Table 3.2: Examples of Financing Options

Financing option	Short description
Engaging with local businesses through green barter	Businesses develop and/or maintain green space in exchange for a formalised right to use the values of those spaces for business purposes and profits. Green barters may involve small as well as medium sized sites and it could serve municipal as well as business objectives
Example: In Lodz, Poland, developers of a new residential area suggested to clear and rehabilitate the nearby park to compensate for the removed trees to build the new area. The	

City Office did not have additional means for rehabilitating the area, thus a green barter was organised between the City Office and the Developer. This was a temporary arrangement, undertaken to solve one single problem; the land is still publicly owned and after rehabilitation its every day management has been taken over by the City Office (Ambrose-Oji et al., 2017).	
Business Improvement District (BID)	BID implies financing and managing improvements to commercial and industrial environments based on the consent by a majority of businesses who accept an additional levy. The municipality carries out the desired infrastructure improvements.
Example: After the opening of a mall in 2002, the Tibarg district in Niendorf, Hamburg, was endangered because of decreasing visitor numbers. In 2010 the local entrepreneurs, organised in an interest group, applied for a BID project at the municipality. The property owners pay about 1.7% of the calculated value of their property annually for 5 years to implement the interventions. The BID was accomplished between 2010 & 2015 with an estimated cost of €1.75 million and mainly focused on physical improvements such as street lighting, bicycle paths, street furniture, green areas and playgrounds. A next BID is planned for 2016-2021 with a budget of €1.2 million, also focusing on marketing (Ambrose-Oji et al., 2017).	
Mobilising investment from municipal enterprises/utilities	Municipal enterprises are businesses owned by local governments that provide services and typically generate revenue for local communities (e.g. utility companies). Municipalities and municipal companies might want to co-invest in interventions that support achieving their strategic and political goals.
Example: Clean Rivers project is 2.6 billion USD project led by the DC Water utility company in the District of Columbia (DC), USA (Adaptation Clearinghouse 2015). The project focuses on implementing large scale green and grey infrastructure upgrades including permeable pavements, green roofs, rain gardens, and rain barrels and downspout disconnections (DC Water, 2015).	
Contractual PPPs	• Management, Operation and Maintenance (O&M): short-term contracts (2-5 years) where a fixed fee is paid to private companies for the management or operation and maintenance of public spaces. • Leases and Affermage: medium-length contract (8-15 years), private entities charge fees to users of services instead of receiving fixed fees from the local authority • Build-Operate-Transfer (BOT), Design-Build-Operate (DBO): output-oriented contracts for the construction or refurbishment of assets, plus operation and management of these assets (Public-Private Partnership Legal Resource Center, n.d.a).
Examples of contractual PPPs include rather standard contracts with the private sector for green space maintenance and operation.	
Institutionalised PPPs	Implies the establishment of an entity held jointly by the public partner and the private partner. The joint entity thus has the responsibility of ensuring the delivery of work or service for the benefit of the public. The establishment of an institutionalised PPP can be done either through an entity where public and private sectors jointly participate or through private sector buying and owning shares in an existing public company (Marques, 2010).

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Example: Friends of the High Line was originally founded by citizens, but through corporation and investments of private and public partners, it has been able to construct, maintain and exploit the high line, an elevated linear park in the west of Manhattan, New York. Friends of the High Line has raised more than $150 million in public and private funds toward the construction of the first two sections of the park. The organisation raises over 90 percent of the High Line's annual operating budget from private donations. Friends of the High Line New York (High Line, n.d.).	
Special assessment district (SAD)	A designated district, whose constituents accept a fee on the full value of a property in return for a specific public improvement that could include NBS. SAD could be established as part of an on-going project, in case the financing provided by the local authority is not sufficient and if the benefits to the local property owners are well-understood. SAD expands the available capital budget and aligns incentives of payees and beneficiaries. The fees are tied to existing rather than anticipated or future development (The World Bank, n.d.).
Example: The Capital crossroads district in Ohio has been improved with the help of financing through SAD. The district covers 360 acres of downtown Columbus, Ohio. The budget is set forth based on the estimated costs for the agreed-upon services, and the assessment is calculated based on property values and front footage in order to meet the budget. Services provided by the district include beautification, trash and graffiti removal, anti-panhandling, homeless outreach, safety patrols, and an umbrella service - among other things. Since 2006, the district has helped foster $2 billion in investments and $548 million in construction projects (Council od Development Finance Agencies, n.d.).	
Tax increment financing (TIF)	Method of financing a project or development in a designated geographic area based on the anticipated increase in property tax assessed on the increase in property value due to a development project implemented in that area. The increase is determined according to the baseline property value prior to the development project (Georgetown Climate Center, n.d.a). The tax revenues that are collected from the increased property value can be collected into a separate fund and used for further development projects. The city can utilise this income to offer loans and subsidies for commercial projects in the area. By creating these districts, cities can spark new private-public partnerships and new economic activity. (Misra, 2018).
Example: Revenue from Chicago's Central Loop TIF has been used to fund the city's Green Roof Improvement Fund, which incentivizes and provides partial reimbursement to commercial buildings that install green roofs to manage stormwater (Adaptation Clearing House, n.d.).	
Partnerships encouraged by external funding programmes (e.g. EU funding)	Initial public-private cooperation concept developed as part of the donor-funded project. However, the mechanism eventually becomes self-sufficient and can support NBS financing efforts beyond the lifespan of the donor-funded project.
Example: GAIA (Green Area Inner-city Agreement to finance tree Planting) – Bologna, Italy The GAIA mechanism uses financial compensation for the carbon footprint of businesses as the main driver for action. The financial compensation is used to purchase plants and	

maintain trees throughout the city. Participation of the town council and local businesses in the GAIA initiative is on a voluntary basis. Interested businesses can request an easy-to-use tool which calculates the quantity of carbon dioxide involved in their processes and services. To neutralize their carbon footprint, the number of trees required to compensate the company's carbon footprint is calculated according to the amount of carbon dioxide which will be absorbed, and the company decides on how many trees it wishes to purchase to compensate its emissions. The city of Bologna has developed clear guidelines that detail the different steps and identifies the cost components, approves the Protocol of Agreement, takes the initiative to start the planting works and pays the tree suppliers. The city also commits to providing a monitoring report every 6 months from the start of the partnership (Climate-ADAPT, 2016a).

3.1.5 Mandatory requirements and tax initiatives

Municipal administrations could enforce regulatory frameworks of a mandatory character requiring private actors to bear the costs of implementing NBS according to pre-established policy objectives. *Figure 3.4* illustrates the conceptual functioning of mandatory mechanisms. In this setting, the municipality sets a mandatory framework which enforces the implementation of NBS projects (the "push" factors). For instance, municipalities in flood-prone regions could create regulations requiring new buildings to implement storm water mitigation measures. As a component of such a framework, cities could also introduce a set of taxes and fees. This would bring additional internal own-source revenues for the cities to finance NBS. Mandatory frameworks should aim at being environmentally effective, cost effective, and bringing additional positive impacts to society (Climate Policy Info Hub, n.d.)

The logic of mandatory schemes is largely focused on how to induce private companies to change their behaviours and reduce the environmental externalities generated by their economic activities. However, the greening of the urban areas often goes beyond reducing private externalities. As it often relates to public spaces, involving private actors might prove difficult. In such contexts, it might be politically contentious to enact regulations requiring private actors to bear the economic costs associated with activities such as converting roads into green corridors, redesigning the urban drainage system or replacing the pavement of public roads with permeable alternatives. However, the revenues obtained from the fiscal instruments can finance such public measures, if the municipal revenues are ring-fenced for NBS implementation.

Depending on the specific policy objectives, a mandatory scheme can be designed to have an effect on a large or small number of private actors. The selection of the scope of the scheme, i.e. determining which private entities must participate, might follow the criteria of:

- economic sector
- size
- spatial location
- type of associated environmental damage

Likewise, the focus of the regulation varies according to the environmental policy objectives: at the city level, one might expect regulations on issues such as rainwater retention, potable and wastewater management, atmospheric emissions of pollutants and greenhouse gases or vegetal coverage. Finally, different levels of stringency can be applied, ranging from very subtly incremental adaptations to drastic, disruptive changes in the behaviour of private actors. Indeed, depending on the specific political, economic and environmental circumstances of the city, the same scheme can apply different combinations of scope and stringency to meet the desired objectives.

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

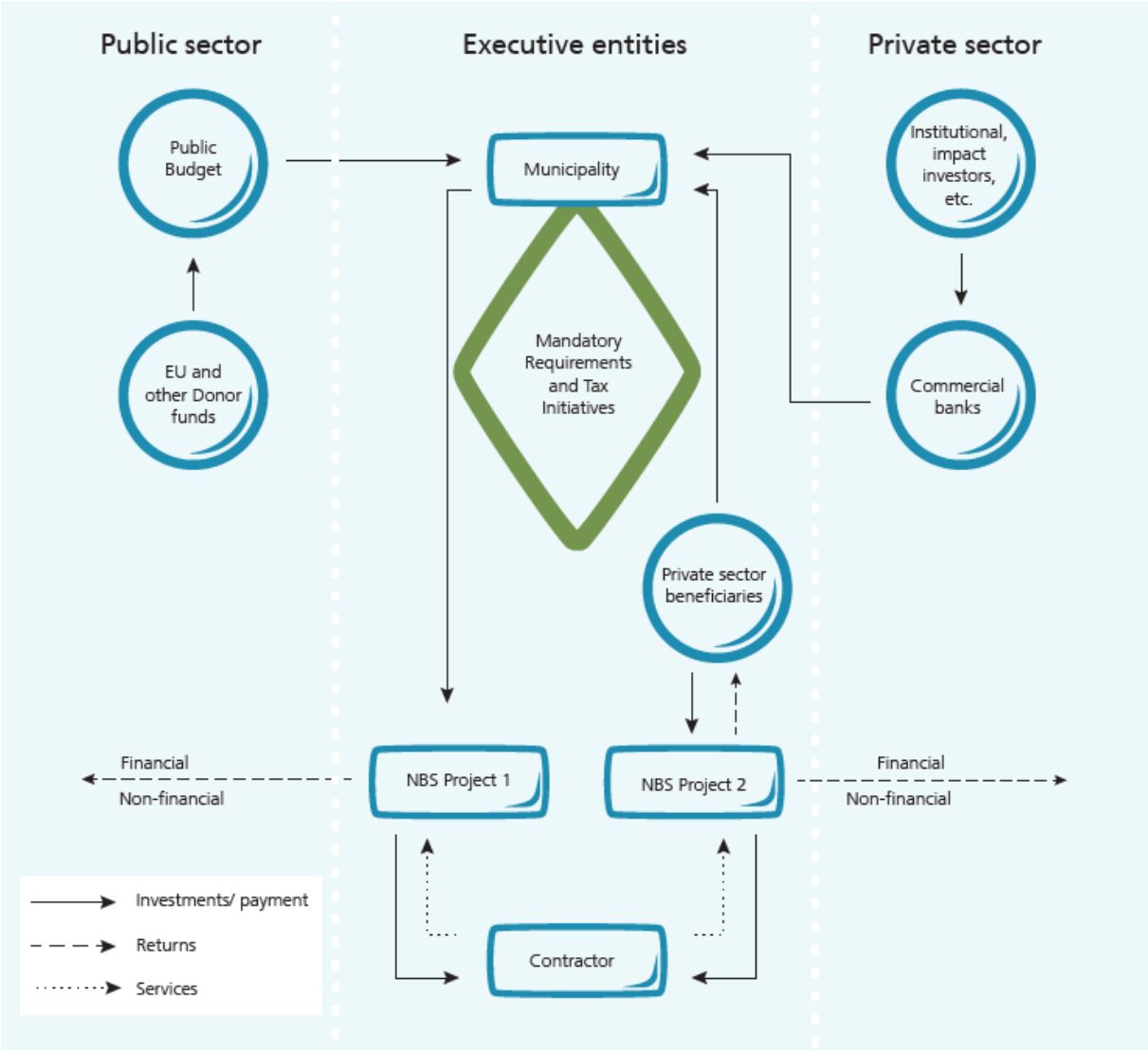


Figure 3.3: Mandatory Requirements and Tax Initiatives

Associated risks

Several risks can affect the performance of a mandatory framework implementation:

- The political and economic context is one of the most important aspects to be considered when assessing the viability of enforcing a mandatory framework.
- Lack of political will to ring-fence the revenues for NBS implementation
- Political opposition and lack of appropriate dialogue between the city and potential participants can have a highly detrimental effect and should be carefully considered.
- The risk of being too strict, thus preventing economic actors to search for more cost-efficient alternatives.

Potential advantages and disadvantages

Mandatory requirements and taxes provide a direct way to push for the implementation of the desired technologies and outcomes. It allows policy makers to distribute the financial burden among a number of actors, sparing the municipal budget from excessive expenses. This could prove useful for technologies like NBS, whose uptake could be slow, due to the rather intangible nature of their returns. However, at the same time the caution should be taken when introducing new regulations to prevent the distortions of the market by taking a too intrusive role or

overburdening of the targeted sectors. This situation could be addressed by combining the regulatory mechanisms with incentive frameworks that would, in turn, provide relevant "pull" factors to promote NBS implementation.

Examples of mandatory tools

Table 3.3: Examples of Financing Options

Financing option	Short description
User fees	User fees are charges incurred by the citizens or companies in return for the delivery of specific services, benefits and utilities. It could include contractual fees, such as fees incurred for using a public park as a venue for an event.
Example: The state park system in the USA, managed by the Department of Parks and Recreation (DPR), contains nearly 280 parks and serves about 70 million visitors each year. The parks cost over $400 million a year to operate. These costs are mainly supported by the state General Fund and revenue generated by the parks, including roughly $100 million in fees paid by park users for day use, camping, and special events (Ames, 2017).	
Private sector financing	Private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems or through coercion (binding regulation).
Example: Green roofs in Tampere. The private developers and building owners support the NBS implementation by setting up green roofs on their properties. Such private sector efforts are mostly guided by the municipal policies that require the construction companies to include a certain amount of green area in their new buildings. The municipality in Tampere has also introduced new planning tools like the Green Factor, which accounts for the green areas in land use and construction projects and thus facilitates the implementation of the NBS policy guidelines	
Storm water fee	Storm water fees are imposed on property owners based on the storm water run-off from the impervious surfaces that need to be accommodated in the storm water drainage system. This fee is collected to generate revenues, which can be used for improvements or installing new infrastructure to better control sewer overflows and storm water run-off (EPA, 2010).
Example: Tampere introduced a storm water fee, which should contribute to municipal expenses for the provision, management and maintenance of the water and sewage system starting in 2019. The municipal costs of the water system are estimated at 5.6 million Euros. Fees will be paid by land owners according to three categories to account for property size and type, as well as surface water quality (e.g. domestic or industrial use). For regular apartments a price ceiling of €250 applies, and the average fee is €74 per year (Tampere Municipality, 2018). Most stormwater management costs should be covered by this income source. It also opens the possibility for the city to finance and built NBS in existing residential areas.	
Land value & value-capture taxation	Land value & value-capture taxation are designed to tax the increase in land value that occurs because of public investment in approximate infrastructures (Chapman, 2017). As a form of real estate taxation, it is a tax on land values only, not taking into account the value of the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

	buildings and infrastructure (Wenner, 2018). The tax revenue can be a result of investment in NBS and/or used for the implementation or maintenance of NBS.
Example: There is well-established research on the positive effect of park and trail investments on the value of adjacent properties. Construction of the High Line in New York City and 606 Trail in Chicago both increased the value of the nearby property. If a portion of that value increase were recaptured through higher land value taxes, those revenues could support the operation, maintenance, and debt service costs of parks (Reimagining the Civic Commons, n.d.)	
Development charges	Development charges are a one-time levy on developers to finance the costs of the additional infrastructure associated with new development or, in some cases, redevelopment. These charges are levied for works constructed by the municipality, and the funds collected must finance the infrastructure needed for the development (Merk, Saussier, Staropoli, Slack, & Kim, 2012).
Example: The Portland metropolitan area has implemented development charges in 2015 after reviewing their budgets and park & recreation strategy, to ensure sufficient financing for capacity increasing and maintenance of park facilities. The charges are 1/5 of the financing sources of the organisation and can only be used for these park facilities that directly affect users positively. Using investment per person provides flexibility for the City to provide the highest priority needs in each area of the City, and avoids the constraints of the previous methodology that is based on acres of park per 1,000 population (Portland Parks and Recreation, 2018).	
Payment for Ecosystem Services (PES)	This scheme aims to protect important public areas for ecosystem services provision (e.g. clean water provision). This mechanism has been used for several cities to support peri-urban and rural watershed (Droste, Schröter-Schlaack, Hansjürgens, & Zimmermann, 2017).
Example: Friends of the High Line was originally founded by citizens, but Catskills (USA) The New York City Department for Environmental Protection funds a Watershed Protection Program to provide high quality drinking water for nine million water consumers. Landowners in the Catskills supply catchment are paid to implement measures which reduce diffuse pollution (Department for Environment, Food and Rural Affairs, 2013).	

3.1.6 Incentive programmes

Often cities lack the financial and technical capacity to execute their functions pertaining to sustainability, resilience and efficiency. Voluntary arrangements, in which private companies work in cooperation with public administrations to reach the desired goals represent an important alternative for cities to address these novel challenges. This usually implies introducing certain “pull” factors to promote voluntary NBS implementation by private actors.

In this type of arrangement, as shown in *Figure 3.4*, the municipal administration is mostly responsible for creating or enabling a regulatory framework in which private actors can develop and implement NBS projects. The framework establishes the policy´s objectives, goals and guidelines. The costs related to the design, implementation and, when necessary, maintenance and operation are borne by private entities.

The use of soft regulations tends to be the norm in such frameworks, with the use of economic and informational incentives. Such incentives include but are not limited to tax credits, subsidies, guidelines, award programs, enabling community-led NBS implementation and

maintenance initiatives, etc. Incentive programmes might be targeted at various private entities ranging from for-profit to non-profit entities, property owners and local communities.

For private enterprises, implementing NBS could be a part of their corporate social responsibility (CSR) initiatives, that address the issue of business legitimacy in terms of how "companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis" (Steurer, 2010). Private companies often engage in projects not directly aimed at a profit but with positive impacts for external parties, among other reasons, to secure legitimacy in the eyes of governments and civil society (Windolph, Harms, & Schaltegger, 2014). However, in a context of multi-stakeholder governance, it also provides them with an opportunity to shape policy arenas according to their preferences. It is important for policy makers to have a clear understanding of private actors´ interests to support the design of adequate positive and negative incentives that align all actors towards common objectives.

As for the local communities, adequate regulatory frameworks need to be designed to allow for the bottom-up initiatives to happen. Cities can enable communities to take advantage of already existing assets in their local area. In this context both regulatory incentives (e.g. permits) and economic incentives (e.g. grants for community groups) could be used. For a city, this has the potential to reduce their costs of implementing and maintaining NBS (Commission for Architecture and the Built Environment and the Asset Transfer Unit, 2010).

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

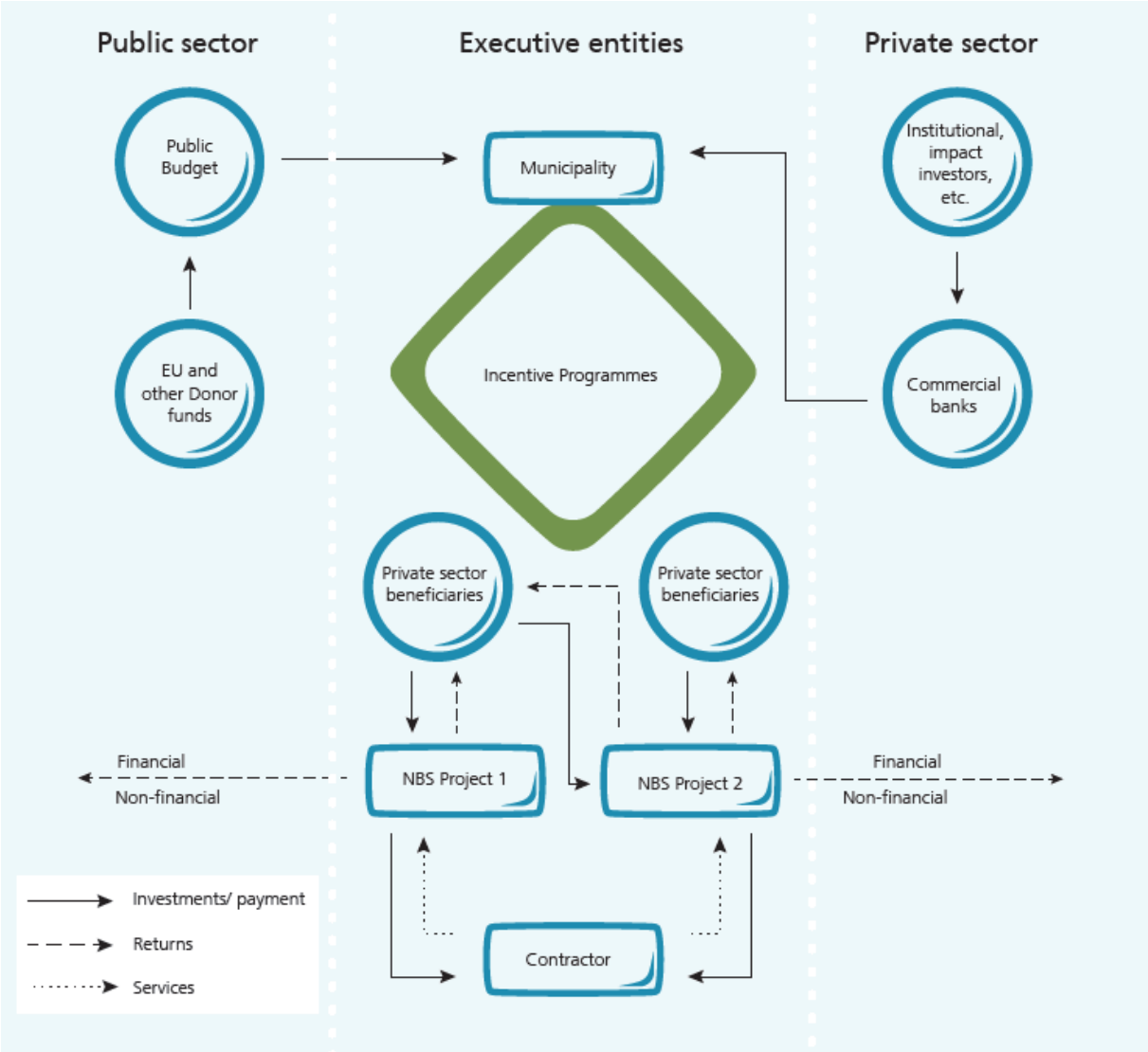


Figure 3.4: Incentive programmes

Associated risks

- Risk of not accomplishing results. Soft regulations aim at both creating incentives for private companies to adhere by and setting common standards to be followed by all parties. Therefore, for it to work properly there has to be sufficient motivation from local private actors to join. Reasons for low engagement might include inadequate sets of incentives, lack of political trust among actors, unfavourable economic circumstances, and lack of appropriate technical capacity to comply with NBS-related requirements.
- "Leadership delusion", i.e. a false perception, often amplified by media, that measures taken by the institutions involved in these policies – municipal administrations and private participants – are having significant impacts, even when objective results show otherwise (van der Heijden, 2017). This mismatch between perception and facts might occur when parties have an interest in projecting an image of success and legitimacy regardless of the actual quality or stringency of these policies. Hybrid models between mandatory requirements and well-targeted incentives might address this risk by setting minimum levels of compliance and rigor.
- The quality of results. In general, policy makers should always have in mind that there is no necessary connection between the involvement of the private sector and the quality

and sustainability of the results. Interests of public and private spheres not always converge and although common belief suggests that the private sector is more technically capable and efficient, in practice that is not always the case (Koppenjan & Enserink, 2009).

Potential advantages and disadvantages

Well-designed incentives encourage private entities to implement infrastructure projects, sparing the city from costs. The main advantage provided by this type of arrangement is flexibility. When appropriately designed, incentives provide participating actors with flexibility in terms of financing, schedules, designs, technologies used, location, which tends to improve the quality of results in an efficient manner. The ability to engage private stakeholders to act without imposing additional costs on companies that cannot afford it, might stand out as a crucial advantage. Because voluntary policies resort mostly to soft regulations, they can be designed as modular frameworks, providing private actors interested in joining with discretion to decide which modules (or projects) within this framework they wish to develop, and at which point in time.

In situations where private entities directly benefit from the provision of public facilities, there is an additional incentive for them to participate and negotiate the location and scope of the interventions (Ruston, n.d.). Increased participation tends to promote cooperation and can provide a more effective means for public participation in planning decisions (Ruston, n.d.).

Although flexibility has numerous advantages for policy design, it tends to be desirable in situations with little urgency. Policy makers should thus carefully consider using this type of approach to deal with urban issues that present significant risks for residents (e.g. floods, fires, landslides, and water and air contamination) and are considered to be urgent by stakeholders.

Examples of incentive programmes

Table 3.4: Examples of Financing Options

Financing option	Short description
Private sector financing	Private companies integrate NBS into their processes and structures either voluntarily through marked based policy instruments, such as incentive systems or through coercion (binding regulation).
Example: Green roofs in Tampere. The private developers and building owners support the NBS implementation by setting up green roofs on their properties. Such private sector efforts are mostly guided by the municipal policies that require the construction companies to include a certain amount of green area in their new buildings. The municipality in Tampere has also introduced new planning tools like the Green Factor, which accounts for the green areas in land use and construction projects and thus facilitates the implementation of the NBS policy guidelines	
Supporting grassroots initiatives	Grassroots initiatives are relatively small-scale initiatives, focused on a specific site, usually located on public or municipal land. Initiatives are normally started and maintained quite autonomously by local residents. They serve citizen and community objectives. By supporting grassroots initiatives municipality could save costs for greening.
Example: DeRuigeHof grassroots association is managing around 13 ha of peri-urban green space in the southeast of Amsterdam. The local community formed the association in the 1980s	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

to protect a green space that had begun to appear on abandoned construction sites, which are owned by the municipality of Amsterdam. The municipality granted the association the right to manage two sites of the municipal land for a symbolic €1 lease agreement. The activities of the association have involved conservation management on meadows, woodland and wetland, which has enhanced the quality of this unplanned green space in terms of wildlife, biodiversity and the connection of local people to the site (Ambrose-Oji et al., 2017)	
Community Management/Ownership of NBS	Management of NBS can be transferred to community groups. It can range from community adopting a green public element to a community asset transfer, which is a transfer of the ownership of the municipal asset to a community organisation. Such initiatives are usually located on municipal land and may involve additional public assets (e.g. playgrounds, etc.).
Example: In Everton, Liverpool UK, multiple areas have been part of a community asset transfer to repair/refurbish and bring back alive former buildings and areas, subject to negligence. These areas and buildings are now leased to different groups that find new purposes for them and thereby generate new cultural and educational values for the community.	
Crowd-funding / sponsorship	Crowd-funding is raising funds for a project, event or activity by asking a large number of people to each contribute a relatively small amount of money. Sponsorship can involve contractual agreements between the sponsoring company and the recipient of the financial support that implies advertising or promotion rights for the company
Example: MyParkScotland offers an online platform created for raising funds for green spaces and parks in Scotland. The website combines elements of project funding for individuals and businesses in an attempt to contribute to the developing of long-term sustainability and endowment funds (My Park Scotland, n.d.)	
City Resolutions	Cities can enact policies which adopt pre-existing standards, simplifying the technical design of policies and outsourcing monitoring and certification activities. It can set a minimum compliance standard and number of participants, while offering incentives for additional efforts adopted by project developers and/or other private sector entities
Example: Chandler´s Resolution 4199/2008 - Arizona, USA. This resolution requires that all new buildings over 5000 square feet (464 m²) must obtain a LEED Silver certificate, and renovations above the same size must follow LEED guidelines. However, the resolution offers incentives for private developments that adopt more stringent LEED requirements, such as faster plan review processes, certification fee reimbursements and public acknowledgement publicised by the municipality (Chandler City Council, 2008) .	
Grants to private property owners and community groups	Cities can provide money to private entities directly for green infrastructure practices or promote them indirectly through low-impact development competitions (Water Environment Federation, 2013).
Example: Hamburg green roof strategy. To reach the city´s target of planting a total of 100 hectares of green roofs, this program offers financial incentives of up to 60% of the investments in installation costs. Building owners adhere voluntarily to the program (European Climate Adaptation Platform, 2016). Costs in this program are divided by the city and building owners, who benefit from not only the reimbursement given by the city, but also lower maintenance costs, reduced energy bills (thanks to the insulation effect provided by green	

roofs) and abatements in rainwater fees. From the city´s perspective, the water retention properties of green roofs are expected to have a positive impact on the costs related to rainwater drainage.	
Reverse auction	It might be cost effective for (smaller) communities to encourage homeowners to control stormwater runoff at the parcel level instead of, or in conjunction with more traditional large, infrastructural practices. An auction could be a cost-effective tool for implementing controls on stormwater runoff quantity at the parcel level. In such case there are multiple "sellers" of the service (i.e. stormwater mitigation) and one "buyer", which is usually the utility company (Thurston, Taylor, Shuster, Roy, & Morrison, 2010). Upfront financing could come from private investors through debt and/or equity (The Nature Conservancy, 2014).
Example: The Rain Catchers project was implemented by the City of Durham to install and evaluate low-impact development retrofits to residential properties. The objective of the project was to reduce pollutants and storm surge by building small-scale projects on private property. Site selection was conducted through an innovative reverse auction process to reduce project costs. Out of 880 residents contacted for participation in the project, 156 sites were slated and ranked for rain gardens, cisterns and tree suitability. Project participants were surveyed later in an effort to track the expectations of the participants, understanding of the project, and whether they were maintaining the installations. After 18 months of monitoring, directing rooftop runoff to rain gardens and cisterns has reduced runoff volumes by 47-97 percent and was therefore very successful (Marraccini, 2015).	
Storm water retention credits	In order to provide more flexibility in their on-site retention rules, cities may create "stormwater credit trading" programs, which allow developers to meet their stormwater retention requirements on their own sites or elect to purchase "credits" for stormwater retention from others who have voluntarily retrofitted their properties through a stormwater credit-trading program. "Demand" for credits will arise as construction projects trigger the on-site retention requirements and developers seek to comply in part through buying credits generated by stormwater management practices (SMPs) located on other properties. Credits would be "supplied" by property owners with relatively low-cost, on-site retention options who voluntarily implement SMPs on their property with the intention of selling retention credits (Dougherty, Hammer, & Valderrana, 2016).
Example: Washington DC implemented a credit system in 2013 and new developments of at least 5,000 square feet must retain the expected runoff from a storm that drops 1.2 inches of rain which covers 90 percent of all downpours in the area. If developers meet 50 percent of their water retention requirement, they can purchase credits from others in the city who have expanded their retention capacity(Spector, 2016).	
Parks Trust	An independent charity which manages city-wide parks and green space portfolio for the benefit of the public. Usually is a self-financing entity which relies on a number of different income sources, but always acts in the service of the public (National Trust, n.d.)
Example: The Parks Trust, formerly known as Milton Keynes Parks Trust, was established by the Milton Keynes Development Corporation to own and manage, in perpetuity, the strategic	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

open space in Milton Keynes. It took a 999 year lease of 4,500 acres and at the same time was given an endowment of around £20m. The endowment was mainly in the form of commercial property in Milton Keynes and the rental income is used to fund the Trust. The Trust's green estate now comprises around 6,000 acres of parks, meadows, river valleys, woodlands, lakes and the landscaped corridors which run along the main grid roads– about 25 percent of the new city area. As the city has continued to grow, new parks and open spaces are being established and transferred to the Trust with an endowment. The endowment sum that is required is the capital sum that we need to invest to generate the annual income to cover the maintenance costs each year in perpetuity (National Trust, n.d.).	
Awards and recognition programs to the property owner	City-led programs that officially certify private properties that have green and blue infrastructure elements. Such practices have the potential to increase property values, which can thus motivate the owners to get certified. On the city scale, more green and blue infrastructure gets established.
Example: Lake Champlain International (LCI) BLUE® certification for watershed-friendly homes. Certified homeowners receive a BLUE certification lawn sign (potential to increase property value). LCI is working with cities to implement a stormwater utility discount for certified homeowners (Water Environment Federation, 2013).	

3.1.7 Municipal funds

Establishing municipal funds could be an alternative financing strategy for promoting private sector participation in NBS implementation. Municipal funds could be used to encourage NBS projects that are implemented by local businesses, residents, housing associations and other relevant private profit and non-profit entities.

The seed capital for the funds is typically secured by the municipality from the internal and/or external funding sources depending on the local context. Such funds call for extensive collaboration between the local governments and international funding programs, donor agencies, as well as credit institutions. Municipalities might also opt for issuing bonds to secure seed capital. The financial involvement of the municipality often helps attract other investors, such as commercial banks, that could further capitalise the fund.

For successful operation of the fund, the municipality needs to set up business models for the fund that would include the fund structure and standard procedures (Cicmanova, Turner I, van Liefland, Kaiser, & Ethuin, 2017). The management of the loans is often outsourced to the external managing entities (e.g. commercial banks), which are selected through the public procurement tenders. Careful planning and risk management are needed to ensure the longevity and functionality of the fund. This includes setting up the eligibility, reporting, collateral and repayment requirements as well as loan terms that would enable the funds to be sustainable and would also serve the purpose of encouraging the desired economic activities (Booth, 2009). The administrational fees need to be selected carefully to ensure they cover the costs, yet are not too high to prevent the borrowing (OECD, 2010). Tracking and monitoring of the loans as well as whether the progress towards the desired policy goals is being made is also crucial for the success of municipal funds. In addition, the municipality might need to provide technical support for the beneficiaries.

The precise set-up of the municipal funds might vary substantially depending on the particular city context as well as the nature of the fund and/or projects being funded. In some cases, such funds could even encompass multiple credit lines. For example, the fund could issue soft loans for the projects that result in social and environmental improvements, while investing in more

commercially-oriented projects that generate higher financial returns and are based on the market interest rates (Energy cities, 2014).

A simplified depiction of this category of financial mechanisms could be observed in *Figure 3.5.*

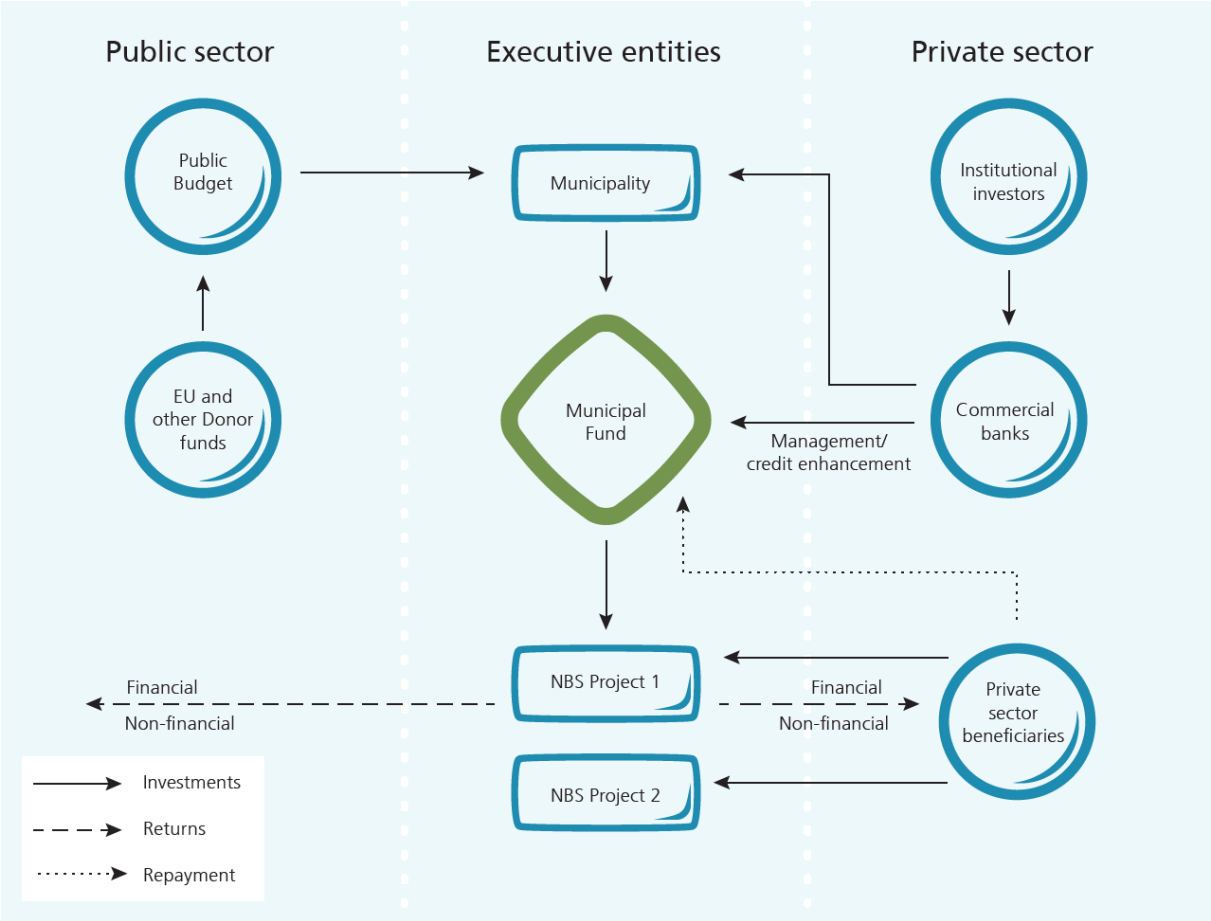


Figure 3.5: Municipal Funds

Associated risks

When implementing this kind of mechanism, the municipality needs to take on the following risks (Douette, n.d.):

- Credit risk – the financial involvement of municipality in municipal credit funds usually implies its responsibility for the defaults of payments that might need to be compensated to the commercial banks.
- Uncertainties related to the technical and operational challenges of the interventions that are supported by the fund (Weisbord & Orlowski, n.d.).
- Political risks if the financial mechanism does not achieve the envisaged goals.

For the municipalities to address the identified risks, they might need to include guarantee components in the loan schemes as well as carefully investigate the potential borrowers. In addition, the clear definition of the eligibility of the projects that qualify for this kind of funding should be derived. Due diligence and monitoring and verification should be carried out. Starting with a smaller budget and low-risk loan financing scheme might be beneficial to test the

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

envisaged scheme and their potential for up scaling as well as attract further investors (Cicmanova et al., 2017).

Potential advantages and disadvantages

The municipal funds enable risk sharing between the various stakeholders: financial institutions, cities, the borrowers and the fund itself (Zoom microfinance, 2015). Such funds have good potential to reach additional leverage and also decrease the risk to the lenders (Hussain, 2013). By deciding on the eligibility of the projects the municipality has the power to stimulate respective market niches as well as push forward the interventions that align with its strategic goals.

However, this group of mechanisms is suitable for the projects and technologies that have the potential to reach relatively well-defined monetary benefits to its beneficiaries. Yet, if the supported projects do not generate any savings, the fund is likely to not be sustainable in the long-run without additional external financing. Due to these characteristics, offering loans to fund NBS might appear implausible and perhaps grant funding could be a more preferred option to encourage private sector investments in NBS. However, loan funding might still make sense, if the conditions can be flexible in terms of repayment schedules and loan maturities designed in a way to fit the needs of a less traditional borrower (EPA, 2017a).In addition, depending on the local context, larger-scale funds, i.e. implemented on a sub-national or national level might be more successful in attracting investors and supporting targeted projects. Municipal funds could also provide support for local businesses that do not necessarily implement NBS but still play a relevant role in the NBS value chain, e.g. provide support to SMEs taking care of the maintenance of NBS.

Examples of municipal funds

Table 3.5: Examples of Financing Options

Financing option	Short description
Revolving fund	The fund offers loans (often soft loans) to the private sector. Repaid loans are reinvested and new loans are issued.
Example: Sustainability revolving fund (SRF) in Hillsboro. Established in 2010, this revolving fund supports projects that demonstrate economic, environmental and/or social returns on investment as well as address City's sustainability goals. So far, the fund has supported five projects, whose generated savings or avoided costs have been reinvested in the fund on an annual basis making SRF self-sustainable. The fund has enabled the city to cut its energy consumption and utility costs (US Department of Energy, n.d.)	
Guarantee fund	Providing guarantees to the beneficiaries that have limited access to credit.
Example: The Municipal Guarantee Fund for SMEs in Sofia. The fund mostly focuses on financing SMEs and start-ups that fulfil the strategic directions defined by the city and have economically sound projects but have difficulties securing sufficient collateral. The fund offers additional benefits to the projects with the social and ecological dimension that generate employment opportunities (Municipal Guarantee Fund for SME Sofia, n.d.)	
Linked deposit loan programs	The treasury deposits funds at the local commercial bank, which then can offer cheaper loans to the beneficiary of the program.
Example: Green Lending Program in Springfield, Illinois. The program was introduced in 2017 focusing on lending to the non-profits and faith-based organisations that have	

difficulties in accessing capital. The program is capitalised using linked deposit programs and it offers loans for financing solar and green infrastructure investments. The program is said to encourage the beneficiaries to reduce carbon emissions, basement flooding and barriers to locally produced food and open space (Faith in Place, 2017).

3.2 NBS financing strategies and considerations in other Horizon 2020 projects

To better understand the NBS financing aspects in the European cities beyond the ones participating in the UNaLab project, the experts of other NBS demonstration projects have been interviewed in a semi-structured manner. The interview guide was composed aiming to explore the type of NBS implemented, NBS financing strategies, private sector role in the financing of NBS, as well as envisaged financial mechanisms for further NBS uptake (please see *4.4. Questionnaire for SCC02 partners – Financial mechanisms*). However, during the initial communication with the projects, it became evident that many of them have only just started working on the NBS financing topic. For this reason, not many projects could share their knowledge. Consequently, the methodological approach has been expanded. In order to explore the relevant NBS financing strategies, this report also provides a short overview of the Urban Nature Atlas. Composed by the Naturvation project, it seems to be the most comprehensive database of the implemented and/or foreseen NBS projects across Europe. The Urban Nature Atlas also provides an indication of the financing structure used to fund NBS projects. For this reason, it serves as a valuable source of information for determining the NBS financing tendencies in the European cities that informs this report.

3.2.1 Lessons learned from other NBS demonstration projects

The representatives of two SCC02 projects – Connecting Nature and Grow Green – were interviewed to gather insights on the financing aspects of NBS. The projects are implementing or have foreseen the following NBS in their cities:

- Establishing/expanding urban parks and green spaces, including pocket parks
- Sustainable urban drainage systems (SUDS)
- Green roofs
- Green walls
- Creating vertical ecosystems

According to the interviewed experts, the majority of NBS funding is provided by the municipal budgets. The municipalities often seem to experience a path-dependency in applying the same sources of finance paired with a lack of knowledge, which might discourage the efforts to find innovative financing approaches for NBS. In addition, the communication issues between planning and budget departments are common in municipalities. This situation is reinforced by the lack of experts on NBS financing.

To guarantee the full potential and sustainability of NBS, cities need to ensure the continuity of funding for new NBS interventions as well as proper maintenance of the already established NBS. In this context, private sector involvement is deemed crucial. For example, city-governments could make the capital expenditure (CAPEX) investment and the private sector cover the maintenance and operational expenditure (OPEX) and thus share the responsibilities of implementing NBS. Yet, experts believe that the engagement of the private sector largely

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

depends on the type of NBS. According to the interviewees, NBS that deliver public goods are not very likely to attract private investors.

Nevertheless, the projects did have some experience in attracting private capital to NBS implementation. According to the experience in the project "Connecting Nature", the private capital investments were leveraged for the financing and operation of green spaces and parks in three project cities:

- Gent. A valley of 8 km long has been turned into a place for social integration
- Glasgow. An open space strategy was implemented considering to convert these areas for people's use.
- Poznan. The nursery owners and the municipality worked together for the planning and maintenance of a series of pocket parks with nurseries throughout the city.

In this project, most private investments were made by the local NGOs followed by donations and membership fees. NGOs have emerged as the most active private entities involved in the project, who helped not only finance NBS, but also facilitate the cooperation with other stakeholders, such as local business owners.

Success factors and recommendations

To determine the suitable financial mechanisms that would help achieve sustainable NBS financing, extensive coordination with the local partners is essential. The "Connecting Nature" experts have expressed their belief that public-private partnerships might hold high potential in attracting the private sector to support NBS implementation and up scaling.

Overall, the interviewed experts recommend avoiding clustering all NBS into one single element, but rather work towards understanding the different types of NBS and their scale and scope of implementation. Consequently, different business cases may apply for NBS categories and some of them might draw more attention from the private sector than others. Overall, experts deem it important that the private sector can clearly visualise the return of investment for each NBS case.

The main recommendations emphasised during the exchange with other NBS demonstration projects are the following:

- Have a wide overview of all the financing options and find and select the most suitable depending on the NBS interventions and the local context.
- Do not place all the expectations on private sector financing, since there are other sources that might be just as interesting and useful.
- Explore alternative financing sources, such as alternative community-based funding.
- Implement a set of suitable regulations, incentives (such as financial, tax and reputational) and to ensure long-term operational contracts (for instance, PPPs).
- Engage with water utility companies that are interested in mitigating run-off and thus are implementing measures that help enhance the city's run-off mitigation capacity.
- Engage with real estate developers.
- Clearly define public and private investment needs.
- Demonstrate and communicate NBS benefits to the private sector.
- Document the success factors and stories.
- Explore how the lessons learned could be transferred to other cities.
- Consider means for NBS cost reduction (e.g. involve volunteers with diverse backgrounds for the different operational tasks).

3.2.2 Urban Nature Atlas: Main findings

For a comprehensive understanding of the relevant factors for NBS financing, the Urban Nature Atlas database (https://naturvation.eu/atlas) and the corresponding report authored by Almassy et al. (2018) have been reviewed. The authors have distinguished 8 categories of NBS that could be observed in *Table 5.3.* Please note that even though these categories are not identical to the NBS classification proposed in *D5.1 NBS Technical Handbook* and the NBS types discussed in the previous section of this report, these data sources still provide useful insights on the identified NBS financing trends.

According to the Urban Nature Atlas, the majority of NBS interventions have been financed by the local authorities. However, the share of private funding in the investigated NBS projects has increased from 24% to 30% in the period between 1990 and 2016 (Almassy et al., 2018). The authors identify corporate investors, NGOs, private foundations and crowd-sourcing as key channels for leveraging private funds. According to their findings, corporate investors tend to focus on NBS that include external building greens (including green roofs, walls and facades), green indoor areas, grey infrastructure with green areas as well as green areas for water management (Almassy et al., 2018). The largest share of the private foundations' and crowdsourcing funding has been allocated to green indoor areas, while NGOs have favoured allotments and community gardens. This is illustrated in *Table 5.3.* The table also depicts the contribution of the public sources towards NBS funding. While some NBS, namely parks, blue areas as well as derelict areas have been funded predominantly by the public budget, others have attracted both public and private capital (e.g. grey infrastructure with green areas, allotments and community gardens, green areas for water management).

In addition, the Urban Nature Atlas provides some insight behind the investment trends associated with the scale of the projects. According to the authors, small-scale NBS projects (<50.000 EUR) were led by non-governmental actors, while large projects (>4.000.000 EUR) were usually government-led.

Even though the typology of NBS presented by Almassy et al. (2018) differs from the one suggested by UNaLab experts, these findings seem to generally resemble the observations made by the UNaLab Front-runner Cities, as well as the interviewed experts from other Horizon 2020 projects. NBS that exhibit public good characteristics seem to be less attractive for private investors. For this reason, the financing strategies that would help to internalise (at least partially) the public benefits and costs implied by the NBS are crucial for leveraging additional investments in NBS that would support this technology beyond the demonstration phase.

3.3 The discussion of the revelant factors for the design of NBS financing strategies

The design of the successful financing strategies requires a complex and very context-oriented process of the definition of objectives, risk assessment and the identification of the roadmaps as well as overarching strategy for NBS implementation. Recognizing the specific actors involved and how they behave and interact with each other, as well as identifying social, cultural, physical, environmental, institutional frameworks in place, bring additional layers of complexity to this process. When drafting business models and financial models this complexity often permeates into their design. Replicability thus becomes challenging. However, based on the analysis presented in the previous sections of this report, some factors have been identified that could support the process of designing adequate NBS financing strategies and promote their uptake by both public and private sectors. The identified factors,

European Commission
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

however, are not definitive answers, but they might help policy makers uncover some of the relevant local context characteristics.

Distribution of responsibilities, benefits and liabilities. The proposed definition of who bears the costs related to a project, and in which proportion, should consider:

- The potential for profits (or reduction of costs) associated with the project. The construction of an urban park or green space could be organised as a PPP, in which different combinations of cost and profit sharing between the city and a private actor are established. However, to justify the distribution of the costs, projects might be expected to result in profits and/or costs savings.
- The more diffuse the distribution of benefits brought up by the project, the less likely the private actors could be willing to participate in the projects. Certain valuation techniques could be employed to monetise the abstract benefits delivered by NBS.
- Projects which recover, mitigate or compensate an environmental impact caused by a specific set of actors (e.g. air and water pollution) could provide a better political justification for the use of mandatory schemes, which implies that private sector bears the majority of costs of the intervention.
- Private actors tend to be more open to additional mandatory expenses in favourable economic contexts. Cities should thus consider not only the economic, but also the political costs and context related to involving the private sector.
- The costs associated with infrastructure projects could be divided into the building, maintenance and, when applicable, operation. The financial structure should consider how costs can be divided into each of these phases.
- The expected availability of capital of public and private actors in the short and long term is determinant to the success of the financial strategy.
- Infrastructure with operational activities (water treatment plants, management and operation of green areas, sustainable urban draining systems) in some cases generate revenues or reduce public expenditures due to efficiency gains. Those which do, are better suited to have private actors engaged as partners, financially and/or technically.
- Legitimacy-seeking can be a strong motivator of private engagement. Projects with high visibility and public support can particularly benefit from voluntary contributions.

Anticipated volume of NBS-related investments. In principle, the greater the costs of a project in relation to the allocated public budget, the more the city might want to find ways to decentralise them. However, some aspects must be considered:

- Technical projects, especially large ones (e.g. retrofitting a city´s district with the wide use of NBS concepts, such as redesigning roads, sidewalks, buildings, drainage system etc.) can be designed as a program comprised of several smaller projects, or modules, depending on the technical characteristics, the timeframe and other factors. Modular project design allows for the development of specific financial strategies at different levels, providing flexibility and a clearer structure to divide costs and responsibilities.
- Public-private arrangements might be a preferred alternative for implementing complex and costly projects. Often, technical knowledge and resources might not be available at a reasonable cost for municipal administrations, thus private capital can provide an alternative to reach the policy objectives without overburdening the public budget. However, this alternative is not in itself simple, as it often requires complex legal and technical provisions. Therefore, a trade-off must be evaluated within the specific context of the city.
- Partnerships are also possible with other public authorities at the municipal level or otherwise (e.g. neighbouring municipalities can form a consortium with support from the state government). It is important to consider the pros and cons of working with

private actors, as well as the possibility of combining private investment with public partnerships.

Ease of access to external financial resources. Private capital should not be seen as a panacea, but rather as an additional financing alternative in the policy making toolbox. As discussed before, the involvement of private capital has its drawbacks and is no guarantee of superior quality in comparison with purely public projects. Alternative external financial sources, such as grants and concessional loans, might also be a feasible alternative that could significantly alleviate the financial burden of the city. Hence, municipalities should systematically compare the financial, technical and political costs and benefits of both alternatives before deciding for any of them (or a combination of both).

Provision of regulated services. NBS projects can focus on implementing or improving existing services, such as those provided by public and private utilities (e.g. water distribution, drainage and treatment).

- Utility services are normally subject to hard regulatory instruments. However, softer instruments can be used in parallel to create incentives for utilities to invest in improvements in energy efficiency, environmental output quality, the reach of services, among others;
- Non-utility, regulated services are less suited for the use of hard instruments. In relation to these services, the city ideally wants to attract private investments that provide the greatest marginal benefits for the city at the lowest marginal costs for users. While the city must retain the right to regulate the provision of these services, incentives for investment such as tax exemptions, refunds and advertisement rights, as well as the creation of a dialogue platform with service providers should be considered in financial planning activities.

Urgency and risk. These factors are politically sensitive and must be carefully considered:

- Schemes based on soft regulations are often subject to the risk of having limited or slow adhesion of private actors. Also, the standards in such schemes are often set at a low level to not scare away potential private participants. Projects that are considered urgent by stakeholders (for example, measures to reduce the risk of and foster the resiliency to increasingly frequent floods) should therefore take precautions in arrangements that rely on voluntary participation.
- Projects whose environmental characteristics involve high levels of risk to citizens (floods, landslides, fires) should ideally be addressed quickly and efficiently. While this is not a recommendation against partnering with private actors, policy makers should carefully consider the legal and political risks involved.

Overall, private capital is increasingly becoming an important driving force that should be utilised for facilitating greater uptake of NBS. It should be considered by current municipal policy makers, due to certain advantages it brings in terms of flexibility, decentralisation of costs and potential quality as well as efficiency gains. However, urban systems are highly complex, and thus the desired role of private capital in sustainable urban development should be clearly defined. The financial strategies to implement NBS policies with the use of private capital must therefore take into consideration the specific political, economic and technical contexts. Customised solutions that maximise benefits and minimises risks of investing in NBS should be developed taking into consideration good practices shared across the community.

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

4. CONCLUSION

This report has provided the key components of the NBS business models, following a business model canvas approach. Overall this method has proven exceptionally useful to engage the UNaLab Front-runner Cities in collecting the information on the NBS that are planned in Eindhoven, Tampere and Genoa. To ensure a wider representation of NBS interventions, going beyond the UNaLab project, this report has also provided an overview of a number of NBS case studies, mostly based on the Oppla database. This data together with the results gathered from the Front-runner Cities directly, has served as a basis for identifying the key features and components of the NBS business models. However, certain limitations have become evident. The quality of the results seems highly dependent on the type of stakeholders and experts involved in the analysis. In fact, municipality representatives might be the optimal stakeholders to highlight the social and environmental value of the NBS but they often fail to identify the direct and indirect benefits for the private sector. In addition, due to the tendency to exhibit intangible benefits that are public goods, alternative tools and methodologies might be needed to capture the full value potential of NBS.

Subsequently, this report has distinguished and discussed in detail five alternative financing strategies that could support NBS implementation and mainstreaming in cities. These financing strategies have been presented to guide the municipal officers in their consideration of the general set up, relationships and actors that could be involved in financing NBS on a strategic, city level. More concrete financing options constituting each of the five financing strategies have been introduced providing examples of definitions of mechanisms that could be used to finance different projects NBS, while following a respective strategy. The financing strategies and options have been derived from academic and grey literature, expert interviews and Urban Nature Atlas database. This exercise has proven priceless for UNaLab project activities. However, the design of the successful financing strategies is often very complex and context-dependent and thus needs to be tailored to meet the needs of specific cities.

5. ANNEXES

5.1 List of the identified financial mechanisms

Identified Green and Blue Infrastructure, climate change adaptation and mitigation, and other relevant financing mechanisms

Table 5.1: List of the identified financial mechanisms

Name	Category
Green bonds	Innovative municipal financing approaches
Cross-departmental budget	Innovative municipal financing approaches
Municipal investment	Innovative municipal financing approaches
External funding sources	Innovative municipal financing approaches
Investment from municipal enterprises/utilities	Innovative municipal financing approaches
Green barter	PPP
BID	PPP
Contractual PPPs	PPP
Institutionalised PPPs	PPP
Other partnerships (EU projects)	PPP
TIF	PPP
User fees	Mandatory Requirements and Tax Initiatives
Private sector financing	Mandatory Requirements and Tax Initiatives
Storm water fee	Mandatory Requirements and Tax Initiatives
Land value & value-capture taxation	Mandatory Requirements and Tax Initiatives
Development charges	Mandatory Requirements and Tax Initiatives
PES	Mandatory Requirements and Tax Initiatives
Supporting grassroots initiatives	Incentive programmes
Community asset transfer	Incentive programmes
Crowd-funding/sponsorship	Incentive programmes
City resolutions	Incentive programmes
Grants	Incentive programmes
Reverse auction	Incentive programmes
Storm water retention credits	Incentive programmes
Parks Trust	Incentive programmes

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Awards and recognition programs	Incentive programmes
Revolving fund	Municipal Funds
Guarantee fund	Municipal Funds
The linked deposit loan program	Municipal Funds

5.2 Description of the Business Model Canvas

There are different definitions of "Business Model", in terms of both structure and contents, but in general, a "business model" represents a plan implemented by a Company to create a value proposition for the targeted customers, to make it and to gain a part of the economic value generated.

A business model can be articulated in conceptual blocks that allow making explicit the most relevant phenomena for the management of a company. This formalism – also known as "Business Model Canvas" – was proposed for the first time by (Osterwalder, 2004). It was further developed in cooperation with Yves Pigneur and Alan Smith and a community of 470 experts in 45 countries and published in "Business Model Generation" (Oliviera & Ferreira, 2011).

The Business Model Canvas is a complete and systemic method that allows reducing the complexity of the business modelling activity, representing in an effective manner all the parts and internal/external dynamics that are within a Business Model, using a visual language (visual thinking logic).

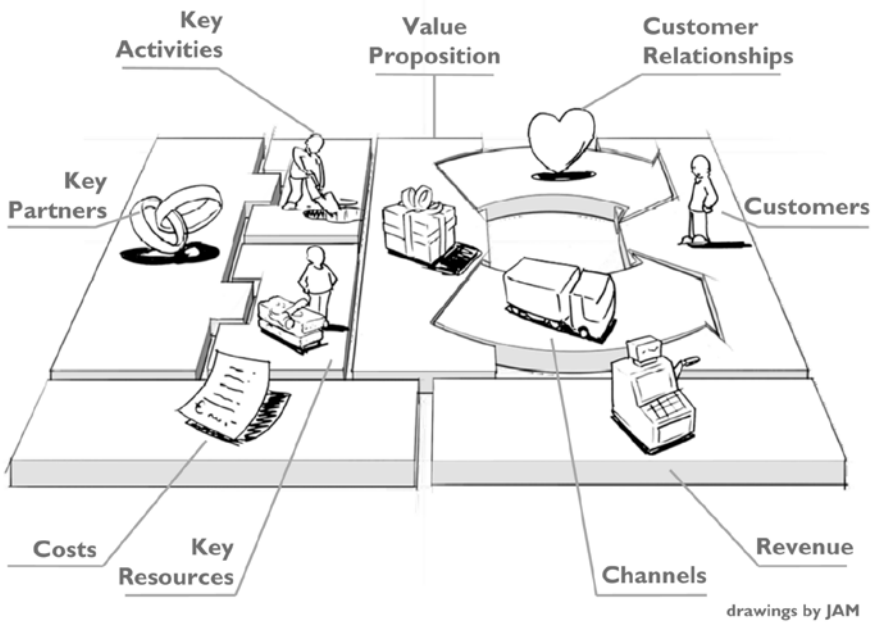
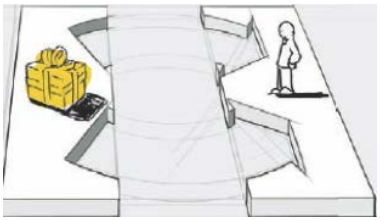
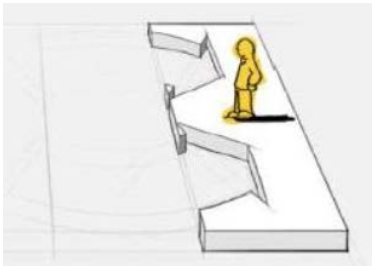
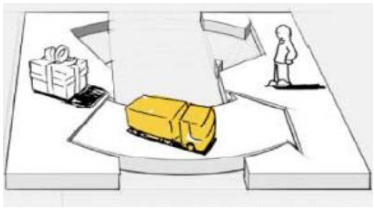
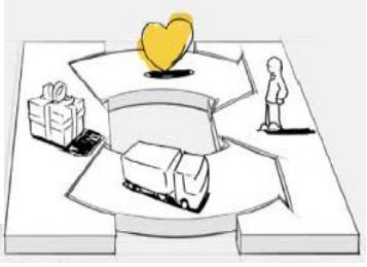


Figure 5.1: Business Model Canvas

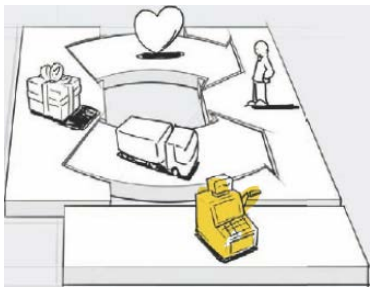
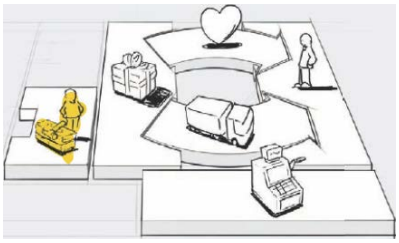
Therefore, the UNaLab business models considered – NBS selected from each Front-runner Cities – will be analysed through the Business Model Canvas methodology (A. Osterwalder concept) that consists on nine conceptual blocks which allow making explicit the most relevant aspects for the business solution.

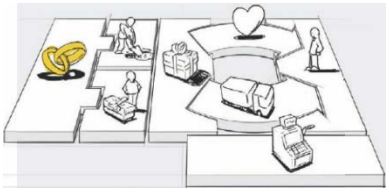
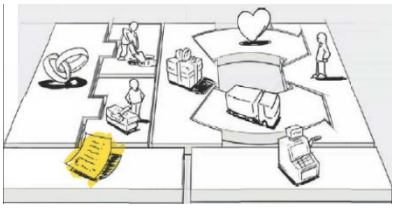
In *Table 5.2* a brief description and meaning of the different blocks of the Canvas are presented, along with an explanation of their relation to the rest of the Canvas blocks.

Table 5.2: Business Model Canvas building blocks

	BM Canvas block - Key Question	Description
#1 Value proposition	 • What do we offer our customers? • What value do we create for our customers? • Which needs do we cover?	Description of the characteristics of the products/services offered, underlining the problems solved and the benefits expected that can be related to different aspects such as: • new needs satisfaction • performances • customised solution • reliability • novel design • risks and costs reduction • competitive price • accessibility • usability
#2 Customer Segments	 • Who are your customers? • What are their needs?	Identification of the client's segments based on their needs/benefits guaranteed. The Customer Segments represents the core of the BM. A company serves one or several customer segments (mass market, niche market, segmented, diversified, multi-sided)
#3 Channels	 • Through what channels do we reach our customers? • Through what channels do we deliver our products/services?	How a company communicates with and reaches its Customer Segments to deliver a Value Proposition. Channels are the company's interface with the customer, thus they play a relevant role in the customer experience. Channels can be physical (e.g. shops) or virtual (e.g. e-commerce/ selling platforms/ own website), direct (own shop) or indirect (franchising, wholesaler, distributors).
#4 Customer Relationships	 • How do we build and maintain good customer relationships?	Identification of the type of relationship the partnership has to establish and maintain with each specific customer segment. Different assistance means are recognised as effective customer relationships as: • Personal assistance based on human interaction • Self-service: the customer should receive all the info needed in order to help himself • Automated services: it mixes a more sophisticated form of customer self-service with automated processes offering customised services based on the customer profile and need • Communities: increasingly, companies are utilizing user communities to become more involved with customers/prospects and to facilitate connections between community members.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

		• Co-creation: more companies are going beyond the traditional customer-vendor relationship to co-create value with customers.
#5 Revenue Streams	 • How do we create revenues? • What value are our customers really willing to pay for? • How would they prefer to pay?	Identification of the revenues model and product/service pricing model. It represents the cash flow that a company generates from each Customer Segment. Revenue streams result from value propositions successfully offered to customers (depend on the type of contract). Revenues can be derived from different sources: physical (e.g. direct selling, fee proportional to the use), virtual (use of the app for selling), grants and crowd funding. There are different ways to generate revenues, such as: • Asset sale. The most widely understood Revenue Stream derives from selling ownership rights of a physical product. • Usage fee. This is generated by the use of a particular service. The more a service is used, the more the customer pays. • Subscription fees. This is generated by selling continuous access to a service. • Lending/Renting/Leasing. This is created by temporarily granting someone the exclusive right to use a particular asset for a fixed period in return for a fee. • Licensing. This is generated by giving customers permission to use protected intellectual property in exchange for licensing fees. Licensing allows rights holders to generate revenues from their property without having to manufacture a product or commercialise a service • Brokerage fees. This derives from intermediation services performed on behalf of two or more parties. • Advertising. This results from fees for advertising a particular product, service, or brand.
#6 Key resources	 • What key resources do we need to fulfil: o our value proposition? o our distribution channels? o customer relationships? o revenue streams?	Identification of Key Resources required for operating successfully. Key resources are the assets required to offer and deliver the Value Proposition to Customers. Key resources can be owned or leased by the company or acquired from key partners. Key resources can be classified as: • Physical assets such as manufacturing facilities, buildings, vehicles, machines, systems, point-of-sales systems and distribution networks • Intellectual resources such as brands, proprietary knowledge, patents and copyrights, partnerships, and customer databases • Human resources • Financial resources and/or financial guarantees, such as cash, lines of credit, or a stock option pool for hiring key employees.
#7 Key Activities		Identification of the most important actions a company must take to operate successfully. They are required to create and offer a Value Proposition, reach markets, maintain Customer Relationships, and earn revenues. Key activities can be related to: • Production: designing, making, and delivering a product in substantial quantities and/or of superior quality. • Problem solving: coming up with new solutions to individual customer problems.

	• Which key activities must we perform to deliver our value proposition?	• Platform/network: networks, match making platforms, software, and even brands can function as a platform
#8 Key Partnership	 • Which partners and suppliers do we work with to deliver our value proposition?	Identification of the Key Partnership describeing the network of suppliers and partners that make the business model work. Companies create alliances to optimise their business models, reduce risk, or acquire resources. Some activities are outsourced and some resources are acquired outside the enterprise. We can distinguish between four different types of partnerships: • Strategic alliances between non-competitors • Strategic partnerships between competitors • Joint ventures to develop new businesses • Buyer-supplier relationships to assure reliable supplies.
#9 Costs structure	 • What types of costs do we have to operate our business model and deliver our value proposition?	The Cost Structure describes all costs incurred to operate a business model. It can be useful to distinguish between two broad classes of business model Cost Structures: • Cost-driven focus on minimizing costs wherever possible. This approach aims at creating and maintaining the leanest possible Cost Structure, using low price Value Propositions, maximum automation, and extensive outsourcing; • Value-driven focus on premium Value Propositions and a high degree of personalised service The categories of cost that interact with a business model may be: • Fixed costs: costs that remain the same despite the volume of goods or services produced such as salaries, rents, and physical manufacturing facilities; • Variable costs: costs that vary proportionally with the volume of goods or services produced; • Economies of scale: cost advantages that a business enjoys as its output expands; • Economies of scope: cost advantages that a business enjoys due to a larger scope of operations.

5.3 Business Model Canvas of selected NBS

The following pictures represent the business model Canvas of the NBS selected by the Front-runner Cities. Such information was collected in UNaLab workshops, through interviews and email exchanges with Front-runner Cities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

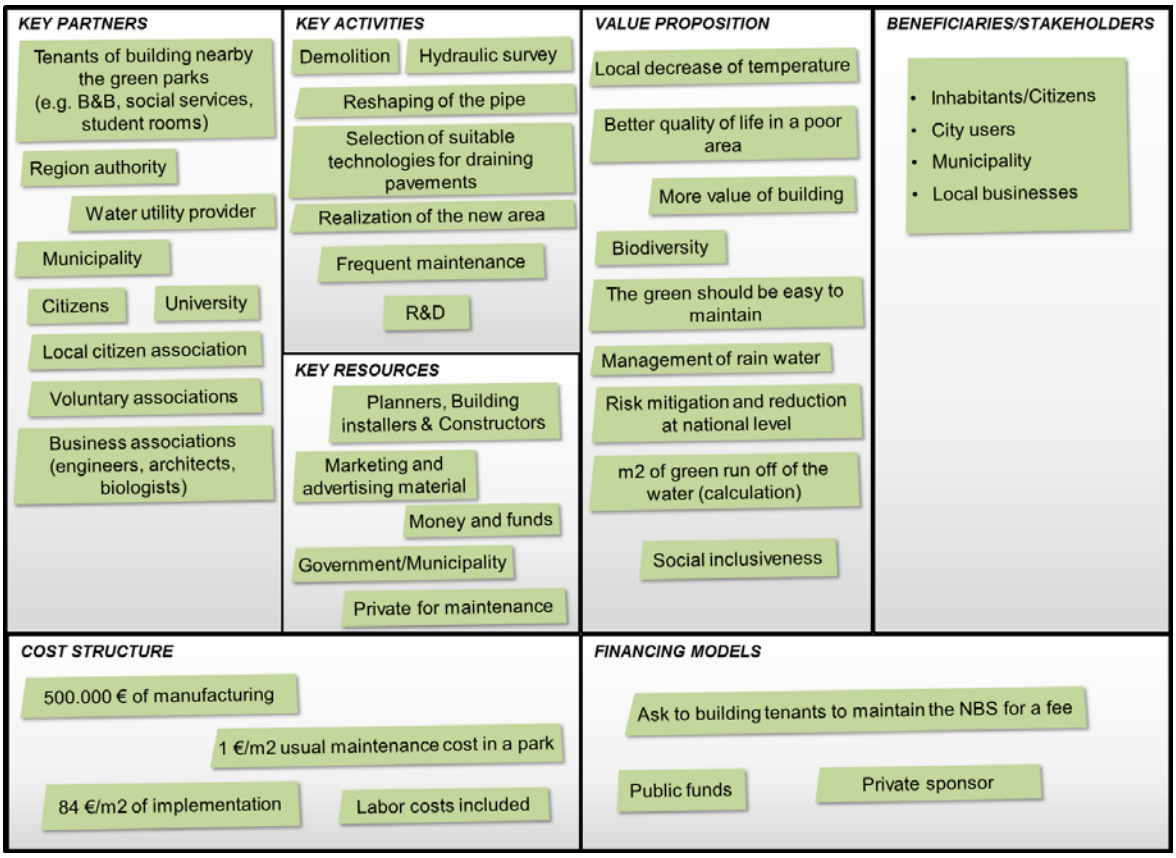


Figure 5.2: Business Model Canvas – Permeable pavements in Genoa

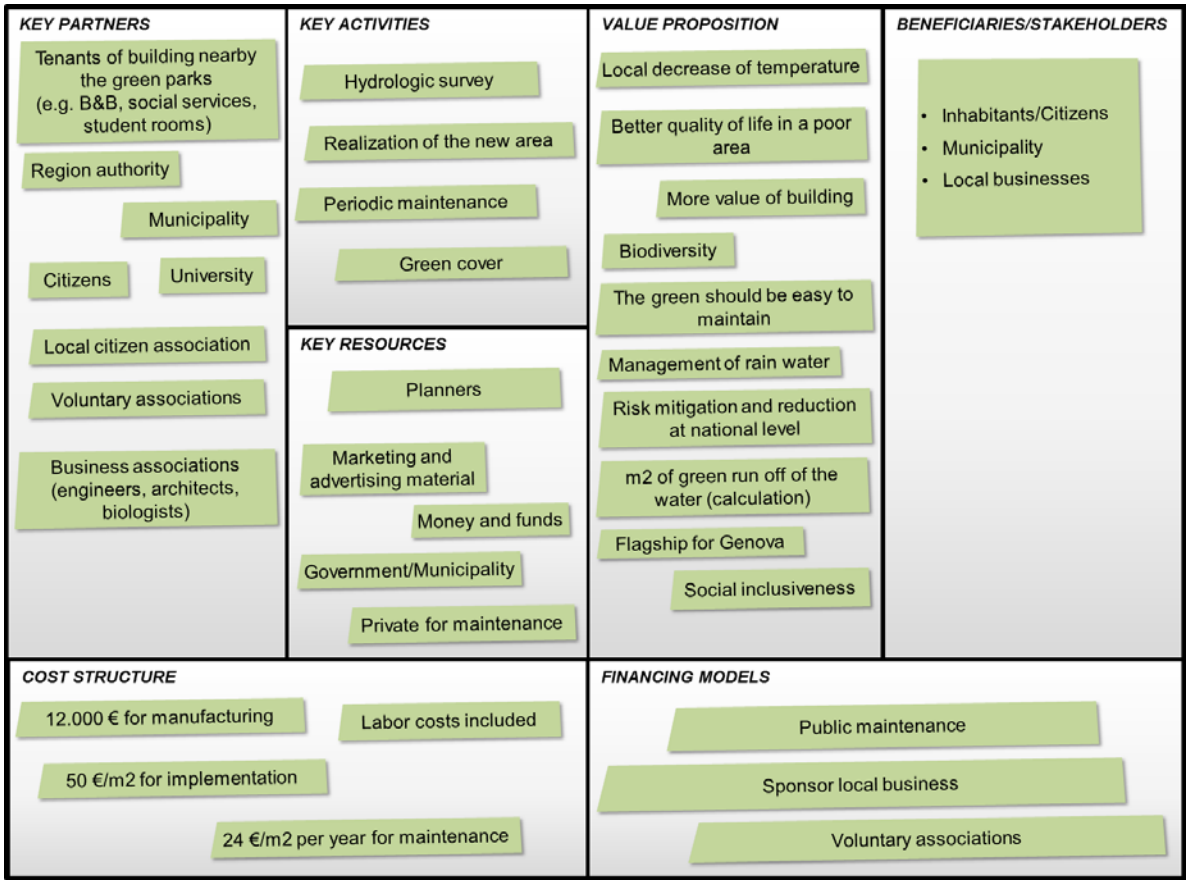


Figure 5.3: Business Model Canvas – Infiltration Basins in Genoa

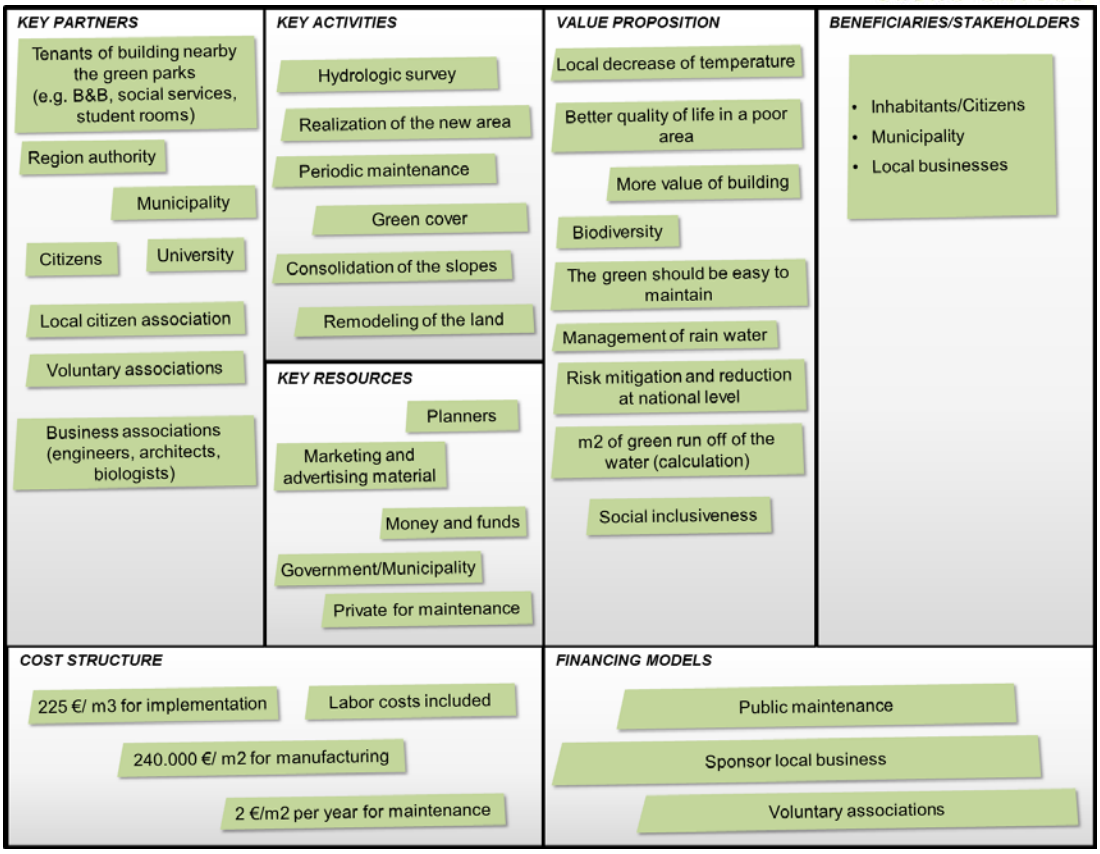


Figure 5.4: Business Model Canvas – Vegetated Gabions Stone in Genoa

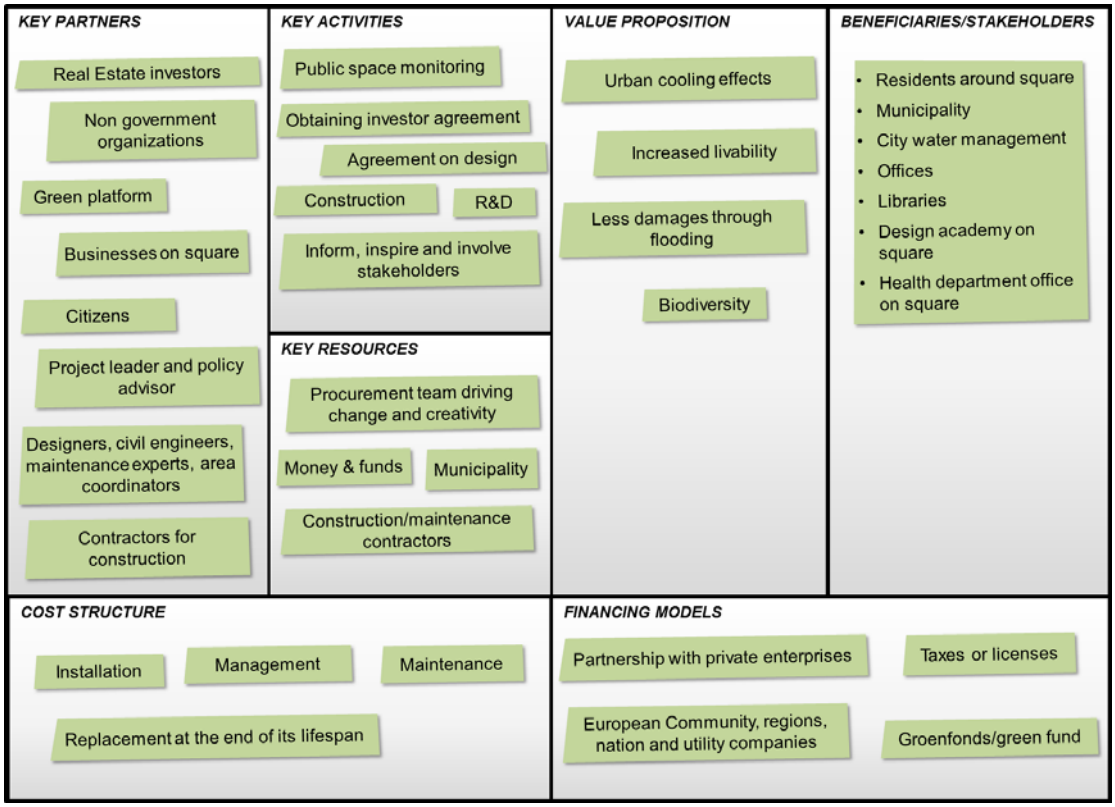


Figure 5.5: Business Model Canvas – Permeable Surfaces and Green Urban Areas in Clausplein (EIN)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

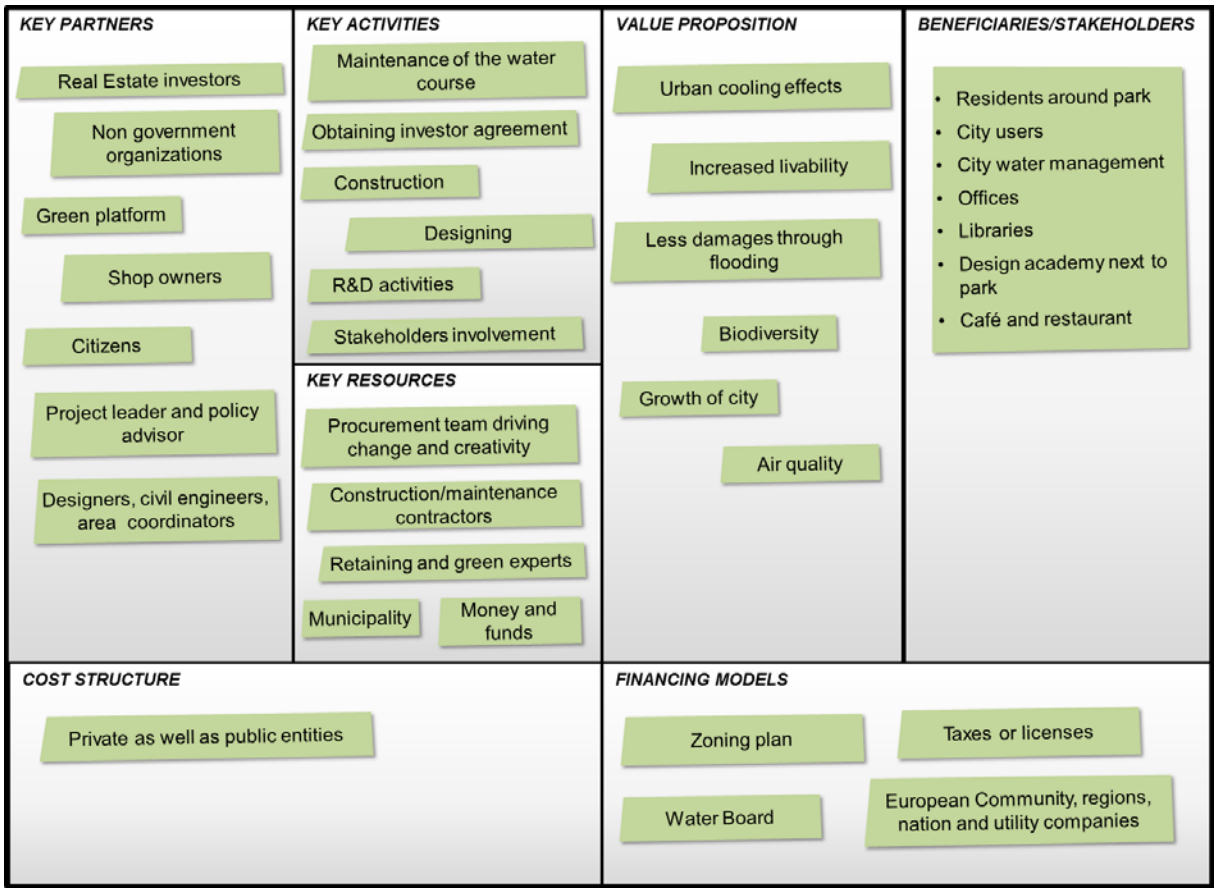


Figure 5.6: Business Model Canvas – Re-establishment of watercourses (daylighting) in Victoriapark (EIN)

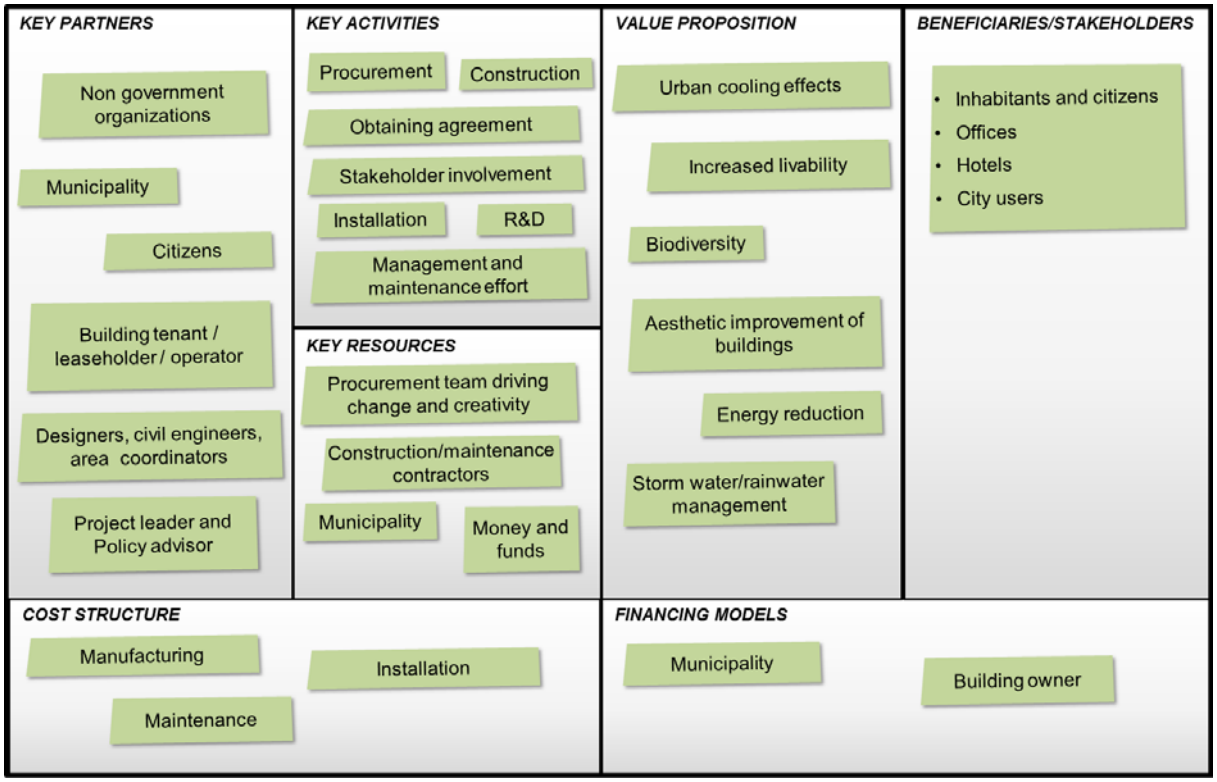


Figure 5.7: Business Model Canvas –Green roofs/green building façades in EIN

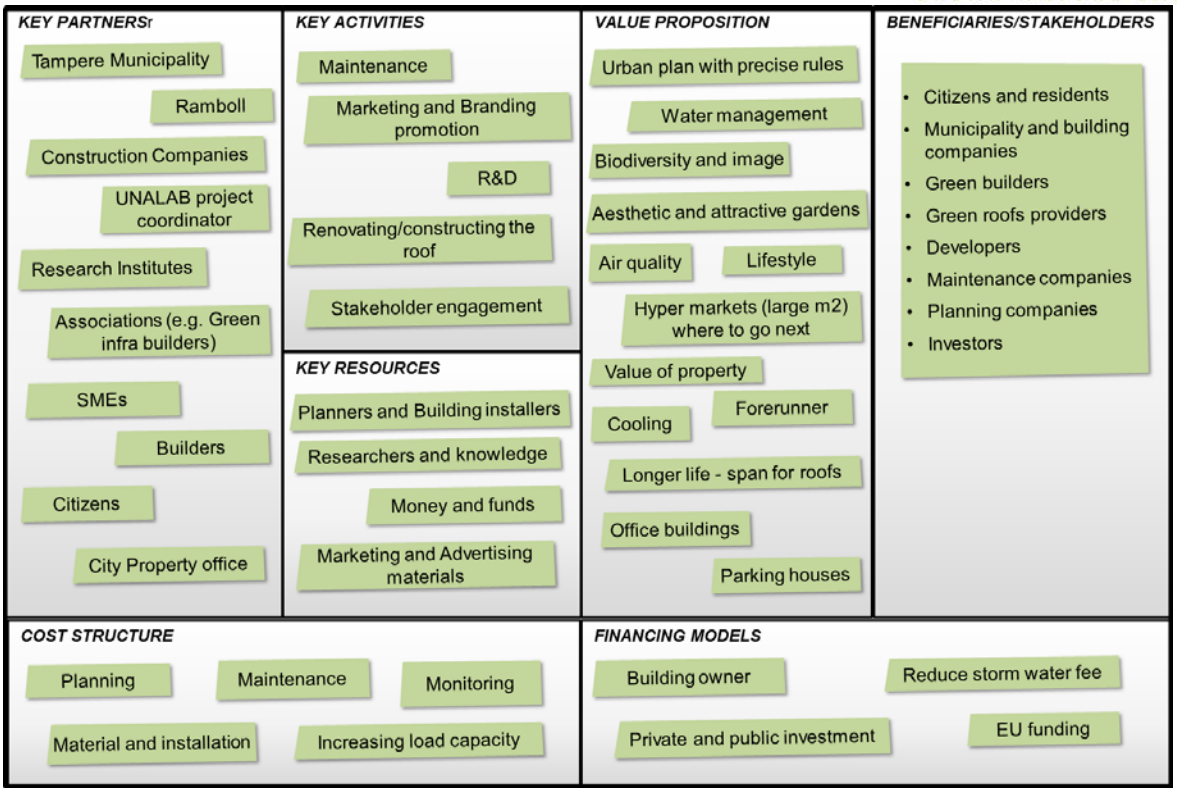


Figure 5.8: Business Model Canvas – Green Roofs in Tampere

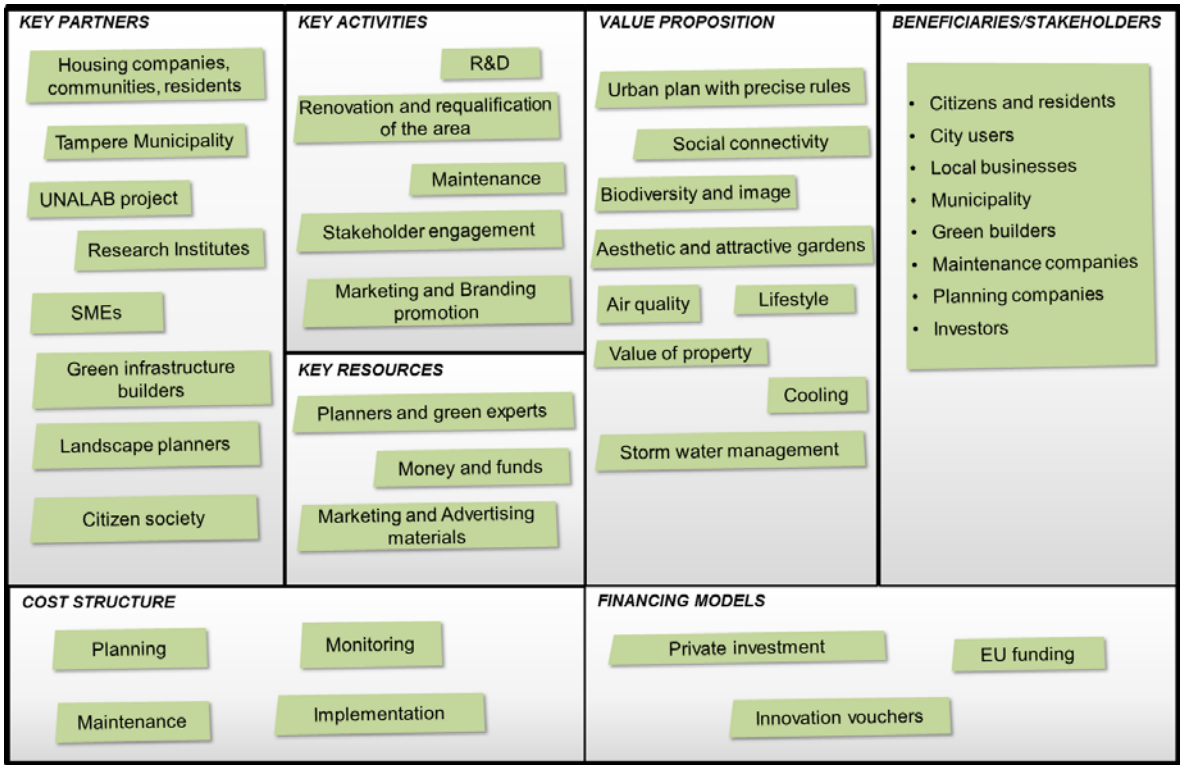


Figure 5.9: Business Model Canvas – Urban gardens with small-scale NBS in Tampere

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

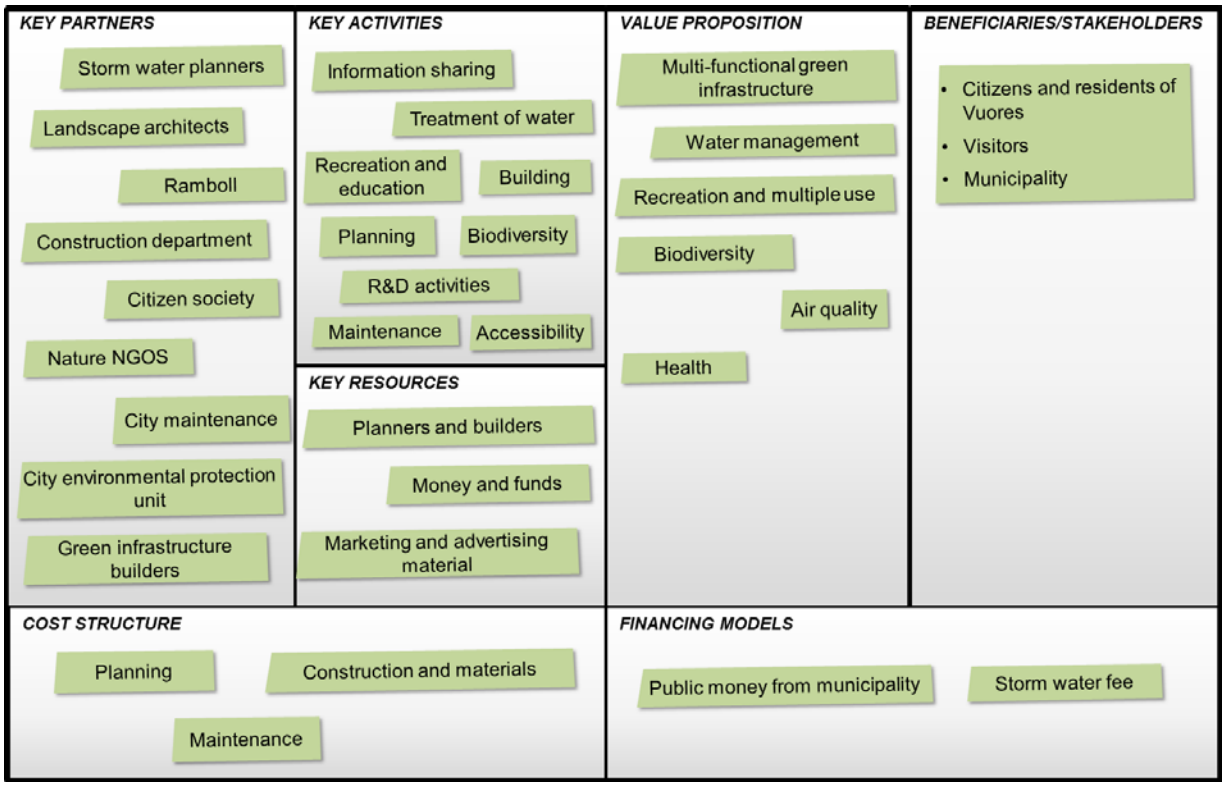


Figure 5.10: Business Model Canvas – Storm water system in Tampere

5.4 Questionnaire for SCC02 partners – Financial mechanisms

Overarching objective: Identify the status quo of financial participation of private actors in NBS projects.

The questionnaire at hand seeks to provide a better insight into the way cities engage private actors to (co)fund NBS projects.

1. What are the concrete NBS that you utilised in the project?

2. What funds have been used to finance the project? (E.g. public budget, public loans, public grants, private loans, grants, etc.)

3. Who were the private actors involved? How did you engage with them? What was their role in the project?

4. In which aspects of the project was the participation of private actors most relevant?

5. Have other types of institutions also participated? If so, how were these involved?

6. In your opinion, which additional factors could have promoted greater participation of private actors in the project?

7. How do your cities plan to fund further NBS projects (beyond your SCC02 demonstration projects)?

8. What funds and financial mechanisms are you planning to use to finance further NBS projects? Are you considering to involve the participation of the private sector? How would you integrate them into your future NBS projects?

9. Do you consider the involvement of private sector funding and partnership a significant success factor in realizing NBS projects?

10. What recommendations would you give with respect to funding NBS projects? What were the main obstacles to getting your NBS project funded?

5.5 Urban Nature Atlas main findings overview

Table 5.3 Funding sources regarding eight categories of NBS. Source: (Almassy et al., 2018)

NBS	Funding source (%)							
	Public sources				Private sources			
	EU funds	Public national budget	Public regional budget	Public local authority's budget	Corporate investment	Funds provided by NGOs	Private foundation	Crowd-sourcing
External building greens	≤10	≤10	≤10	**21-30**	**21-30**	<10	<10	<10
Grey infrastructure with green areas	<10	**11-20**	<10	**31-40**	**11-20**	<10	<10	<10
Parks and semi natural green areas	<10	**11-20**	**11-20**	**31-40**	<10	<10	<10	<10
Allotments and community gardens	<10	<10	<10	**31-40**	≤10	**11-20**	<10	<10
Green indoor areas	<10	<10	<10	**11-20**	**21-30**	1-10	**21-30**	**11-20**
Blue areas	**11-20**	**11-20**	**11-20**	**31-40**	1-10	1-10	1-10	1-10
Green areas for water management	1-10	**11-20**	**11-20**	**31-40**	**11-20**	1-10	1-10	1-10
Derelict areas	**11-20**	**11-20**	**11-20**	**31-40**	1-10	1-10	1-10	1-10

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

6. REFERENCES

Adaptation Clearing House (n.d.). City of Chicago Tax Increment Financing and Green Roof Improvement Fund. Retrieved from https://www.adaptationclearinghouse.org/resources/city-of-chicago-tax-increment-financing-and-green-roof-improvement-fund.html

Almassy, D., Pinter, L., Rocha, S., Naumann, S., McKenna, D., Abhold, K., & Bulkeley, H. (2018). *Urban Nature Atlas: A Database of Nature-Based Solutions Across 100 European Cities*. Retrieved from Naturvation website: https://naturvation.eu/sites/default/files/result/files/urban_nature_atlas_a_database_of_nature-based_solutions_across_100_european_cities.pdf

Ambrose-Oji, B., Gerohasi, E., Mattijssem, T., Szaraz, L., Vander Jagt, A., Hanbsen, R., . . . Rolf, W. (2017). *Innovative Governance for Urban Green Infrastructure Planning and Implementation*. GREEN SURGE Deliverable 6.3. Retrieved from https://greensurge.eu/working-packages/wp6/D6.3_GREENSURGE-WP6-guide-FINAL.pdf

Ames, A. (2017). *Improving State's Approach to Park User Fees*. Retrieved from Legislative Analyst's Office website: https://lao.ca.gov/reports/2017/3527/park-user-fees-011217.pdf

APMG International (2018). 5.4. Disadvantages and Pitfalls of the PPP Option. Retrieved from https://ppp-certification.com/ppp-certification-guide/54-disadvantages-and-pitfalls-ppp-option

Booth, S. (2009, August). *Revolving Loan Funds. Basics and Best Practices*. TAP Webinar. Retrieved from https://www.energy.gov/sites/prod/files/2014/05/f15/tap_webinar_20090826_booth.pdf

Brandolini, P., Cevasco, A., Firpo, M., Robbiano, A., & Sacchini, A. (2012). Geo-hydrological risk management for civil protection purposes in the urban area of Genoa (Liguria, NW Italy). *Natural Hazards and Earth System Sciences*, *12*(4), 943–959. https://doi.org/10.5194/nhess-12-943-2012

Chandler City Council (2008). Resolution No. 4199. Retrieved from https://verderiver.org/wp-content/uploads/2017/07/city-of-chandler-resolution-4199.pdf

Chapman, J. (2017). Value Capture Taxation as an Infrastructure Funding Technique. *Public Works Management & Policy*, *22*(1), 31–37. https://doi.org/10.1177/1087724X16670395

Cicmanova, J., Turner I, van Liefland, S., Kaiser, M., & Ethuin, P. (2017). *Financing the energy renovations of residential buildings thourgh soft loans and third-party investment schemes*. Retrieved from Infinite Solutions website: http://www.energy-cities.eu/IMG/pdf/guidebook_softloans_web.pdf

Climate Bonds Initiative (n.da). *How to issue a green city bond: The green city bonds overview*. Retrieved from https://www.climatebonds.net/files/files/How-to-Issue-Green-City-Bonds.pdf

Climate Bonds Initiative (n.d.b). *How to issue a green muni bond: Green muni bonds playbook*. Retrieved from https://www.climatebonds.net/files/files/Green%20City%20Playbook.pdf

Climate Bonds Initiative (n.d.c). San Francisco Public Utilities Commission. Retrieved from https://www.climatebonds.net/certification/sfpuc

Climate Policy Info Hub (n.d.). *1. Differentiating non-market-based and market-based instruments*. Retrieved from https://climatepolicyinfohub.eu/node/103/pdf

Climate-ADAPT (2014). Urban river restoration: a sustainable strategy for storm-water management in Lodz, Poland. Retrieved from https://climate-adapt.eea.europa.eu/metadata/case-studies/urban-river-restoration-a-sustainable-strategy-for-storm-water-management-in-lodz-poland

Climate-ADAPT (2015a). Green roofs in Basel, Switzerland: combining mitigation and adaptation measures: Case study. Retrieved from https://climate-adapt.eea.europa.eu/metadata/case-studies/green-roofs-in-basel-switzerland-combining-mitigation-and-adaptation-measures-1

Climate-ADAPT (2015b). Isar-Plan – Water management plan and restoration of the Isar River, Munich (Germany): Caste study. Retrieved from https://climate-adapt.eea.europa.eu/metadata/case-studies/isar-plan-2013-water-management-plan-and-restoration-of-the-isar-river-munich-germany

Climate-ADAPT (2016a). GAIA - Green Area Inner-city Agreement to finance tree planting in Bologna. Retrieved from https://climate-adapt.eea.europa.eu/metadata/case-studies/gaia-green-area-inner-city-agreement-to-finance-tree-planting-in-bologna/#challenges_anchor

Climate-ADAPT (2016b). Water sensitive urban and building design. Retrieved from https://climate-adapt.eea.europa.eu/metadata/adaptation-options/water-sensitive-urban-and-building-design

Commission for Architecture and the Built Environment and the Asset Transfer Unit (2010). *Community-led spaces: A guide for local authorities aand community groups*. Retrieved from https://www.designcouncil.org.uk/sites/default/files/asset/document/community-led-spaces_1.pdf

Council od Development Finance Agencies (n.d.). Special Assessments Overview. Retrieved from https://www.cdfa.net/cdfa/cdfaweb.nsf/pages/special-assessments.html

Cuttaree, V. (2008). *Key Success Factors for PPP projects Based on International Experience*, St. Petersburg. Retrieved from (http://siteresources.worldbank.org/INTECAREGTOPTRANSPORT/Resources/Session1_SuccessfactorsPPPsfromInternationalExperience.ppt

Department for Environment, Food and Rural Affairs (2013). *Payments for Ecosystem Services: A Best Practice Guide*. Retrieved from https://www.cbd.int/financial/pes/unitedkingdom-bestpractice.pdf

Douette, A. (n.d.). *Credit Guarantees: Risks and Supervision*. Workshop on Credit Guarantee Funds. Retrieved from http://www.economistiassociati.com/files/Douette_Credit_Guarantees_Risks&Supervision_ENGLISH.pdf

Dougherty, S., Hammer, R., & Valderrana, A. (2016). *Stormwater credit trading programs*. Retrieved from NRDC website: https://www.nrdc.org/sites/default/files/stormwater-credit-trading-programs-ib.pdf

Droste, N., Schröter-Schlaack, C., Hansjürgens, B., & Zimmermann, H. (2017). Implementing Nature-Based Solutions in Urban Areas: Financing and Governance Aspects. In N. Kabisch, H. Korn, J. Stadler, & A. Bonn (Eds.), *Theory and Practice of Urban Sustainability Transitions. Nature-Based Solutions to Climate Change Adaptation in*

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Urban Areas (Vol. 9, pp. 307–321). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5_18

ECRR (2014). What is river restoration? Retrieved from http://www.ecrr.org/RiverRestoration/Whatisriverrestoration/tabid/2614/Default.aspx

Energy cities (2014). *Financing schemes increasing energy efficiency and renewable energy use in public and private buildings*. Retrieved from http://www.energy-cities.eu/IMG/pdf/infinite_solutions_comparative_analysis_web.pdf

Environmental Protection Agency of The United States of America (August 2010). *Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure: (EPA-841-F-10-004)*. The United States.

Environmental Protection Agency of The United States of America (2017a). *Financing Options for Nontraditional Eligibilities in the Clean Water State Revolving Fund Programs*. Retrieved from https://www.epa.gov/sites/production/files/2017-05/documents/financing_options_for_nontraditional_eligibilities_final.pdf

Environmental Protection Agency of The United States of America (2017b). *Green Infrastructure in Parks: A guide to collaboration, funding and community engagement*. Retrieved from https://www.epa.gov/sites/production/files/2017-05/documents/gi_parksplaybook_2017-05-01_508.pdf

European Climate Adaptation Platform (2016). Four pillars to Hamburg's Green Roof Strategy: financial incentive, dialogue, regulation and science (2016). Retrieved from https://climate-adapt.eea.europa.eu/metadata/case-studies/four-pillars-to-hamburg2019s-green-roof-strategy-financial-incentive-dialogue-regulation-and-science

Faith in Place (2017). Announcing New Green Lending Program!: Green Lending Program to Help Non-Profits and Faith-Based Organizations Removes Barrier When Borrowing for Improvements. Retrieved from https://www.faithinplace.org/news/announcing-new-green-lending-program

Georgetown Climate Center (n.d.a). Green Infrastructure Toolkit. Retrieved from https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html

Georgetown Climate Center (n.d.b). *Green Infrastructure Toolkit: How to Pay for Green Infrastructure: Funding and Financing*. Retrieved from https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/introduction.html?full

GIZ (2018). *Green Bonds - Ecosystem, Issuance Process and Case Studies*. Retrieved from https://webapp.sebgroup.com/mb/mblib…/giz_seb_greenbondpublication_web.pdf

High Line (n.d.). NYC High Line. Retrieved from https://www.thehighline.org/history/

Hospes, O., Dewulf, A., & Faling, M. (2016). *Inclusiveness in Public-Private Partnerships: NGO Views and Strategies*. Report for the Netherlands Environmental Agency (PBL). Retrieved from Wageningen University Public Administration and Policy Group website: https://www.wur.nl/upload_mm/2/9/3/191a6df4-b025-4f19-adc9-06b9e926ec9e_FINAL%20REPORT%20Inclusiveness%20in%20Public-Private%20Partnerships%20May%202016.pdf

Hussain, M.Z. (2013). *Financing renewable energy options for developing financing instruments using public funds*. report No. 76556. Retrieved from The World Bank website:

http://documents.worldbank.org/curated/en/196071468331818432/pdf/765560WP0Finan00Box374373B00PUBLIC0.pdf

Koppenjan, J. F. M., & Enserink, B. (2009). Public-Private Partnerships in Urban Infrastructures: Reconciling Private Sector Participation and Sustainability. *Public Administration Review*, *69*(2), 284–296. https://doi.org/10.1111/j.1540-6210.2008.01974.x

Marques, R.C. (2010). What are the different types of PPP arrangements? Retrieved from http://regulationbodyofknowledge.org/faq/private-public-partnerships-contracts-and-risks/what-are-the-different-types-of-ppp-arrangements/

Marraccini, D. (2015). City of Durham, N.C. Department of Public Works Awarded 2015 EPA Region 4 Rain Catcher Award. Retrieved from City of Durham, N.C. Department of Public Works Awarded 2015 EPA Region 4 Rain Catcher Award

Merk, O., Saussier, S., Staropoli, C., Slack, E., & Kim, J.-H. (2012). *Financing Green Urban Infrastucture*. OECD Regional Development Working Papers.

Misra, T. (2018). The Trouble With TIF: Cities love to use Tax Increment Financing to boost development. Should they? Retrieved from https://www.citylab.com/solutions/2018/09/the-trouble-with-tif/569815/

Municipal Guarantee Fund for SME Sofia (n.d.). *Municipal Guarantee Fund for SME Sofia*. Retrieved from https://aecm.eu/wp-content/uploads/2018/09/MGFSME_brochure_ENG.pdf

My Park Scotland (n.d.). About. Retrieved from https://www.mypark.scot/about/

National Trust (n.d.). Future Parks initiative. Retrieved from https://www.nationaltrust.org.uk/features/our-vision-for-the-future-of-parks

The Nature Conservancy (2014). *NatLabCreative Financing Solutions for Green Infrastructure*. Retrieved from http://www.theconservationfoundation.org/conservation/images/Keynote%201%20Natlab_Beyond_Basics_Chicago_2014%282%29.pdf

Naturvation (n.d.). Alna Environmental Park. Retrieved from https://naturvation.eu/nbs/oslo/alna-environmental-park

OECD (2010). *Facilitating Access to Finance: Discussion Paper on Credit Guarantee Schemes*. Retrieved from http://www.oecd.org/global-relations/45324327.pdf

Oliviera, M. A. Y., & Ferreira, J. P. (2011). Business Model Generation: A handbook for visionaries, game changers and challengers. *African Journal of Business Management*, *5*(7). Retrieved from https://core.ac.uk/download/pdf/15567621.pdf

Oppla (n.d). Green Living Room - Ludwigsburg. Retrieved from https://oppla.eu/casestudy/17555

Oppla (n.d.). Szeged - NBS for urban regeneration and adaptation to climate change. Retrieved from https://oppla.eu/casestudy/19448

Osterwalder, A. (2004). *The Business Model Ontology a Proposition in Design Science Appraoch* (PhD). The University of Lausanne, Lausanne. Retrieved from http://www.hec.unil.ch/aosterwa/PhD/Osterwalder_PhD_BM_Ontology.pdf

Portland Parks and Recreation (2018). *System Development Charges (SDCs)*. Retrieved from https://www.portlandoregon.gov/parks/article/523731

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052
Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions

Postmes, L. (2014). *Eindhoven goes greener.*

Public-Private Partnership Legal Resource Center (n.d.a). PPP Arrangements / Types of Public-Private Partnership Agreements. Retrieved from https://ppp.worldbank.org/public-private-partnership/agreements

Public-Private Partnership Legal Resource Center (n.d.b). Risk Allocation, Bankability and Mitigation in Project Financed Transactions. Retrieved from https://ppp.worldbank.org/public-private-partnership/financing/risk-allocation-mitigation#currency

Reimagining the Civic Commons (n.d.). *Value Capture in the Commons*. Retrieved from http://civiccommons.us/app/uploads/2018/11/Final_RCC_Value-Capture_Updated-Oct-2018_Pages.pdf

Rosca, O. (2018). EBRD finances green infrastructure in Romania's Craiova. Retrieved from https://www.ebrd.com/news/2018/ebrd-finances-green-infrastructure-in-romanias-craiova.html

Ruston, D. (n.d.). *Let's make a deal: negotiating developer contributions through Voluntary Planning Agreements in New South Wales* (Bachelor's dissertation). UNSW. Retrieved from https://www.be.unsw.edu.au/sites/default/files/upload/pdf/schools_and_engagement/resources/_notes/5A4_14.pdf

Selbig, W. (n.d.). Evaluating the potential benefits of permeable pavement on the quantity and quality of stormwater runoff. Retrieved from https://www.usgs.gov/science/evaluating-potential-benefits-permeable-pavement-quantity-and-quality-stormwater-runoff?qt-science_center_objects=0#qt-science_center_objects

Spector (2016). Turning Stormwater Runoff Into Everyone's Business. Retrieved from https://www.citylab.com/solutions/2016/03/stormwater-runoff-credits-nature-conservancy-washington-dc/473700/

Steurer, R. (2010). The Role of Governments in Corporate Social Responsibility: Characterising Public Policies on CSR in Europe. *SSRN Electronic Journal.* Advance online publication. https://doi.org/10.2139/ssrn.2342120

Susdrain (n.d.a). Houndsden Road Rain Gardens, London: Case study. Retrieved from https://www.susdrain.org/case-studies/case_studies/houndsden_road_rain_gardens_london.html

Susdrain (n.d.b). *Queen Mary's Walk, Llanelli*. Retrieved from https://www.susdrain.org/case-studies/pdfs/queen_mary_s_walk_llanelli_final_v2.pdf

Tampere Municipality (2018). Hulevesimaksuun kolme maksuluokkaa. Retrieved from https://www.tampere.fi/tampereen-kaupunki/ajankohtaista/tiedotteet/2018/04/17042018_7.html#

Terhell, S.-L., Cai, K., Chiu, D., & Murphy, J. (2016). *Cost and Benefit Analysis of Permeable Pavements in Water Sustainability*. Retrieved from UC Davis website: http://watermanagement.ucdavis.edu/files/5414/3891/2393/A03_Terhell_Cai_Chiu_Murphy_ESM121_FinalReport.pdf

Thurston, H. W., Taylor, M. A., Shuster, W. D., Roy, A. H., & Morrison, M. A. (2010). Using a reverse auction to promote household level stormwater control. *Environmental Science & Policy*, *13*(5), 405–414. https://doi.org/10.1016/j.envsci.2010.03.008

UNDP (n.d.). *Green Bonds*. Retrieved from https://www.sdfinance.undp.org/content/sdfinance/en/home/solutions/green-bonds.html#mst-3

United States Environmental Protection Agency (n.d.). Green Infrastructure: Green Infrastructure Funding Opportunities. Retrieved from https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities

US Department of Energy (n.d.). SUSTAINABILITY REVOLVING FUND. Retrieved from https://betterbuildingsinitiative.energy.gov/implementation-models/sustainability-revolving-fund

Van der Heijden, J. (2017). *Innovations in Urban Climate Governance*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108233293

Water Environment Federation (2013). Five Types of Green Infrastructure Incentive Programs. Retrieved from https://stormwater.wef.org/2013/01/five-types-of-green-infrastructure-incentive-programs/

Weisbord, D., & Orlowski, M. (n.d.). *Investment Primer For Green Revolving Funds*. Retrieved from Sustainable Endowments Institute website: http://greenbillion.org/wp-content/uploads/2012/05/Investment_Primer.pdf

Wenner, F. (2018). Sustainable urban development and land value taxation: The case of Estonia. *Land Use Policy*, *77*, 790–800. https://doi.org/10.1016/j.landusepol.2016.08.031

Windolph, S. E., Harms, D., & Schaltegger, S. (2014). Motivations for Corporate Sustainability Management: Contrasting Survey Results and Implementation. *Corporate Social Responsibility and Environmental Management*, *21*(5), 272–285. https://doi.org/10.1002/csr.1337

The World Bank (n.d.). Special Assessment Districts. Retrieved from https://urban-regeneration.worldbank.org/node/19

The World Bank (2017). PUBLIC-PRIVATE PARTNERSHIPS Reference Guide. Version 3. Retrieved from https://library.pppknowledgelab.org/documents/4699

Zoom microfinance (2015). *Guarantee funds - a response to agricultural credit risk*. Retrieved from http://www.fao.org/3/a-bp975e.pdf

European Commission

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 730052

Topic: SCC-2-2016-2017: Smart Cities and Communities Nature based solutions