NBS Business Model – Water sensitive urban design measures

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

1. WATER SENSITIVE URBAN DESIGN MEASURES BUSINESS MODEL

Water Sensitive Urban Design (WSUD) is an emerging urban development paradigm aimed to minimise hydrological impacts of urban development on the environment. 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.

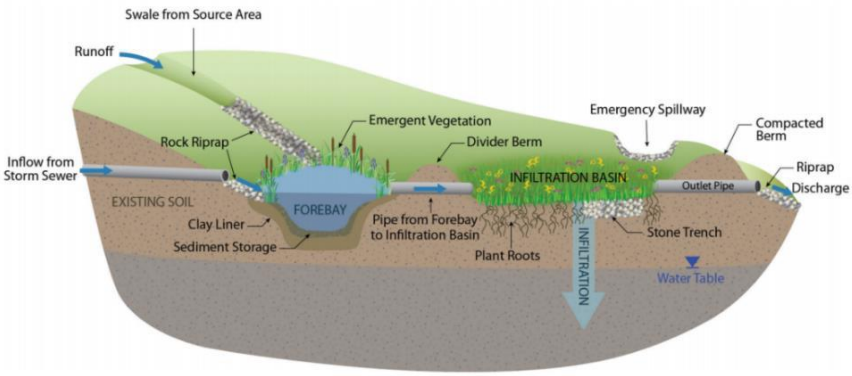

Figure 1.1: Example of Infiltration Basin[1]

The following *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 1.1 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 1.1: 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
• 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

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

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- 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
• Facilitation group composed by representatives from the main municipal departments
• Steering group composed by project partners and funders from different departments and research institutes
	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:
	  ○ Biofilter ≈ 50 000 €
	  ○ The retention pond and alluvial meadow ≈ 50 000 €
	  ○ 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 €.

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.

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2. CASE STUDIES: BUSINESS MODEL OF WATER SENSITIVE URBAN DESIGN MEASURES

1.1 Genoa experience - Infiltration Basins

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.

1.1.1 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**.

1.1.2 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.

1.1.3 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.

1.1.4 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)

1.1.5 Key activities

The following *Table 2.1* identifies the key activities needed to deliver the proposition of the infiltration basins.

Table 2.1: Key activities foreseen for the implementation of the infiltration basins

Key activities	Description
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

1.1.6 Key resources

The following *Table 2.2* identifies key resources needed to fulfil the proposition of the infiltration basins.

Table 2.2: 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

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1.1.7 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 2.3 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 2.3: Costs for the infiltration basins

Type of costs	Cost for implementation
Manufacturing	18.000 €
Implementation	120 €/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.

Figure 2 below summarizes the main sections of the Business Model Canvas developed for Infiltration Basins in Genoa.

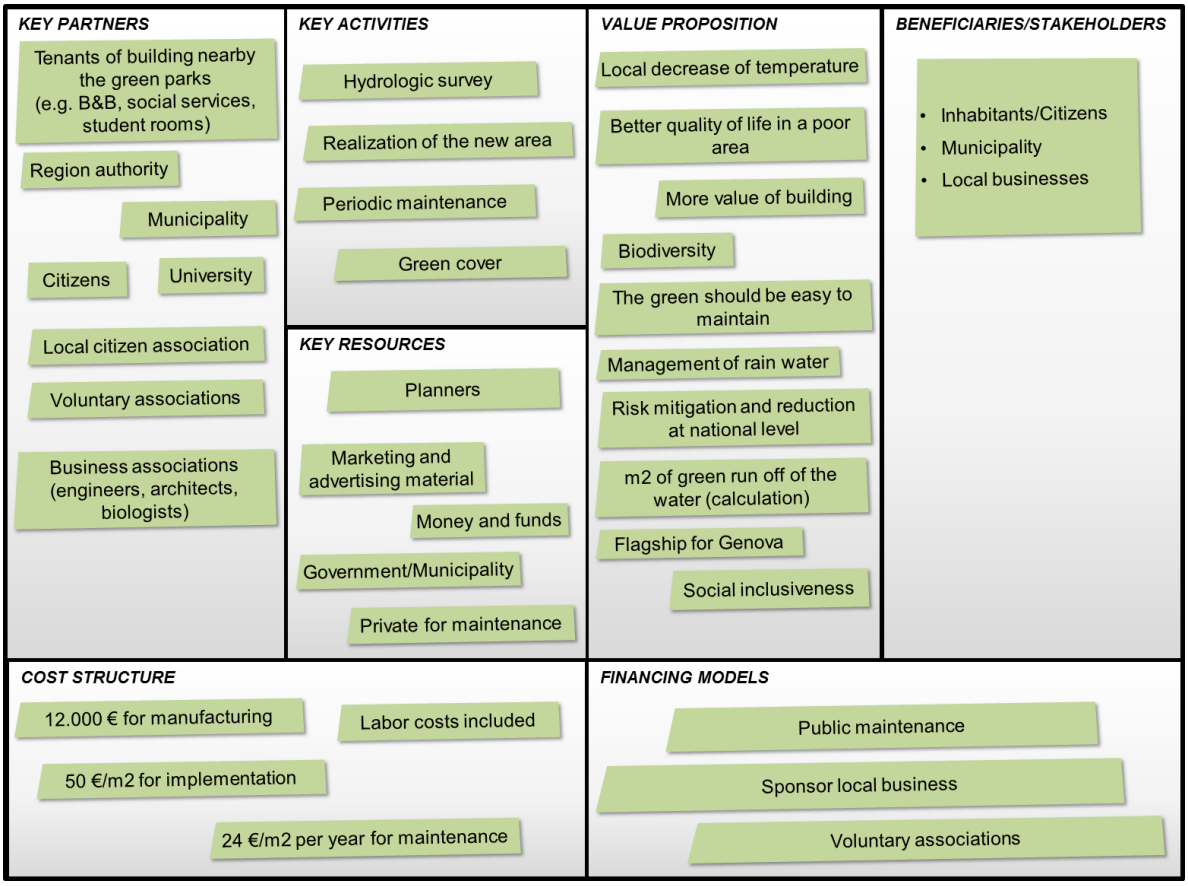

Figure 2: Business Model Canvas – Infiltration Basins in Genoa

1.2 Tampere experience – Storm Water System (Bio Filter, Retention Basins, Alluvial Meadow)

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 (2022) NBS in public areas consists of 7 bioswales, 10 retention ponds, 3 wetlands, willow treatment, alluvial meadows and a biofiltration system. The biofilter is installed in Virolaisten Park (area of ca. 650 m2) while the retention/infiltration basin with alluvial meadows are installed in Tervaslammen Park (area of ca. 700 m2).

1.2.1 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.

1.2.2 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

1.2.3 Financing models

According to an 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, 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 could apply for 3 x 10 000 € vouchers to plan and implement communal gardens to improve storm water management,

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biodiversity and recreational use of gardens. Housing companies and other communities financed the rest of the implementation not covered by innovation vouchers.

From 2018, a storm water fee (amounting in total 5,6 million €/year)[2] 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.

1.2.4 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.

1.2.5 Key activities

The following *Table 2.4* identifies the key activities needed to implement the storm water system and reach the aim of the project.

Table 2.4: 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.

[2] Figures from Municipality of Tampere

Workshops and online surveys	Information sharing through active stakeholder participation in co-creation workshop and online surveys
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

1.2.6 Key resources

Table 2.5 identifies the key resources needed to fulfil the proposition of the project.

Table 2.5: 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

1.2.7 Cost structure

Table 2.6 summarises the costs for the implementation of the selected NBS, estimated by the Municipality of Tampere.

Table 2.6: 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 horse paddock ca. 30000 €
Maintenance	3-12 €/m2 per year

Figure 2 below summarizes the main sections of the Business Model Canvas developed for Storm water system in Tampere.

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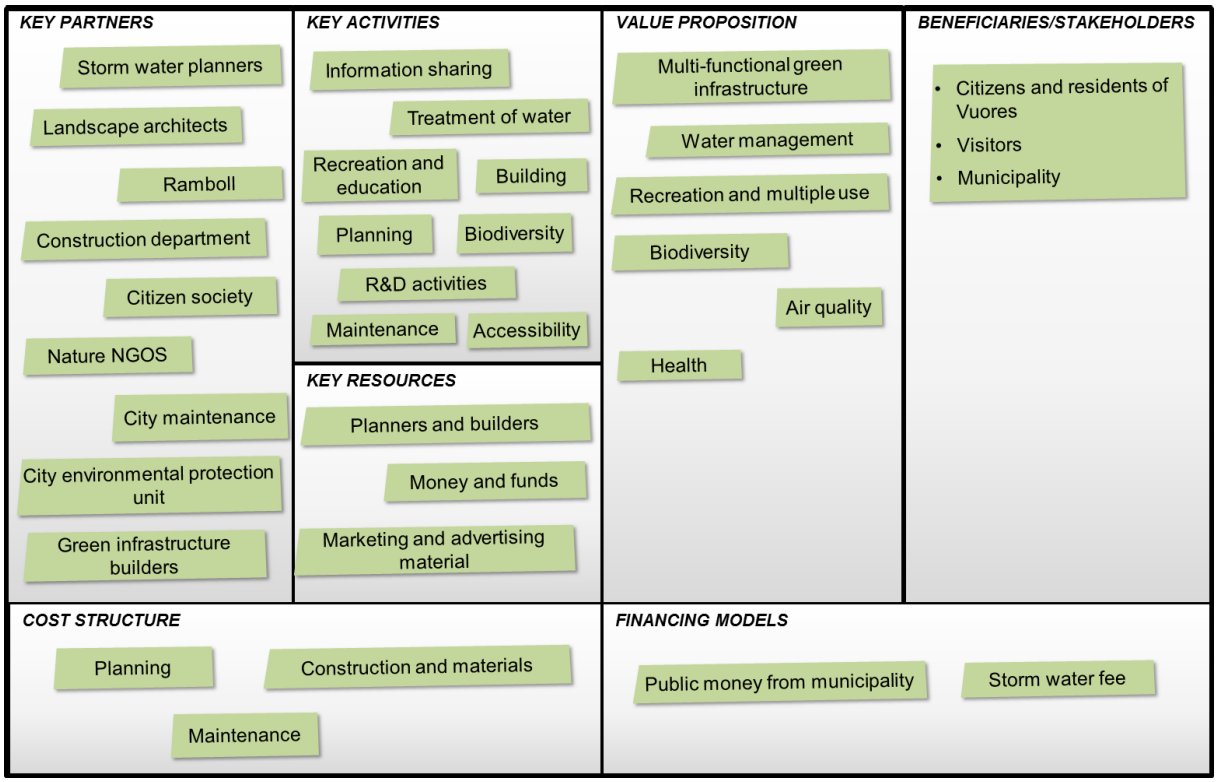

Figure 3: Business Model Canvas – Storm water system in Tampere