NBS Business Model - Permeable Surfaces

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

1. PERMEABLE PAVEMENTS BUSINESS MODEL

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.

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, to maintain high permeability.

Figure 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 1 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 *D5.1 NSB Technical Handbook*.

Table 1: 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	Costs
• 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	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

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work or to use other services or amenities • Local businesses (e.g. shops, real estate agencies, professional associations etc.)	• Implementation costs ≈ 80-100 €/m2 • Maintenance costs ≈ 0-2 €/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
  ○ 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
  ○ Crowdfunding/sponsorship: for example, private sponsors can be involved in maintenance activities	

1.1 A case study: 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.

In the framework of the UNaLab Front-runner Genoa city, 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.

1.1.1 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.

1.1.2 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.

1.1.3 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. 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.

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1.1.4 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)

1.1.5 Key activities needed to deliver the proposition of the project

Table 2: 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

1.1.6 Key resources needed to fulfil the proposition of the project

Table 3: 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.

1.1.7 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 4 were estimated by the Municipality of Genoa, including labour cost.

Table 4: 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	0,6 €/m2 year	1,5 €/m2 year

There are no expected costs regarding social and environmental aspects.

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

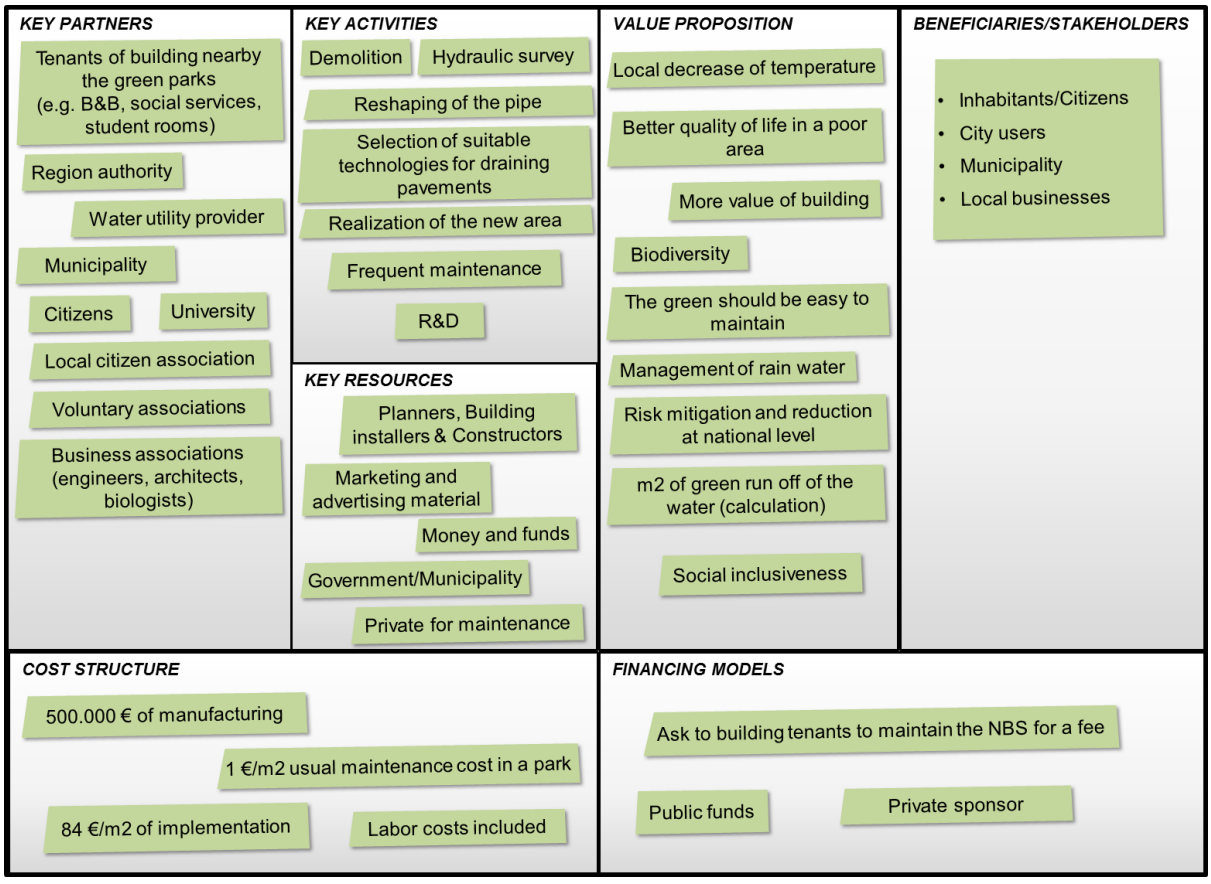

Figure 2: Business Model Canvas – Permeable pavements in Genoa

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1.2 Benefits/advantages at social, economic and environmental level

The main benefits expected from the implementation of permeable pavements within the wider requalification plan for Gavoglio Barracks, are reported at environmental, economic and social level in the following Figure.

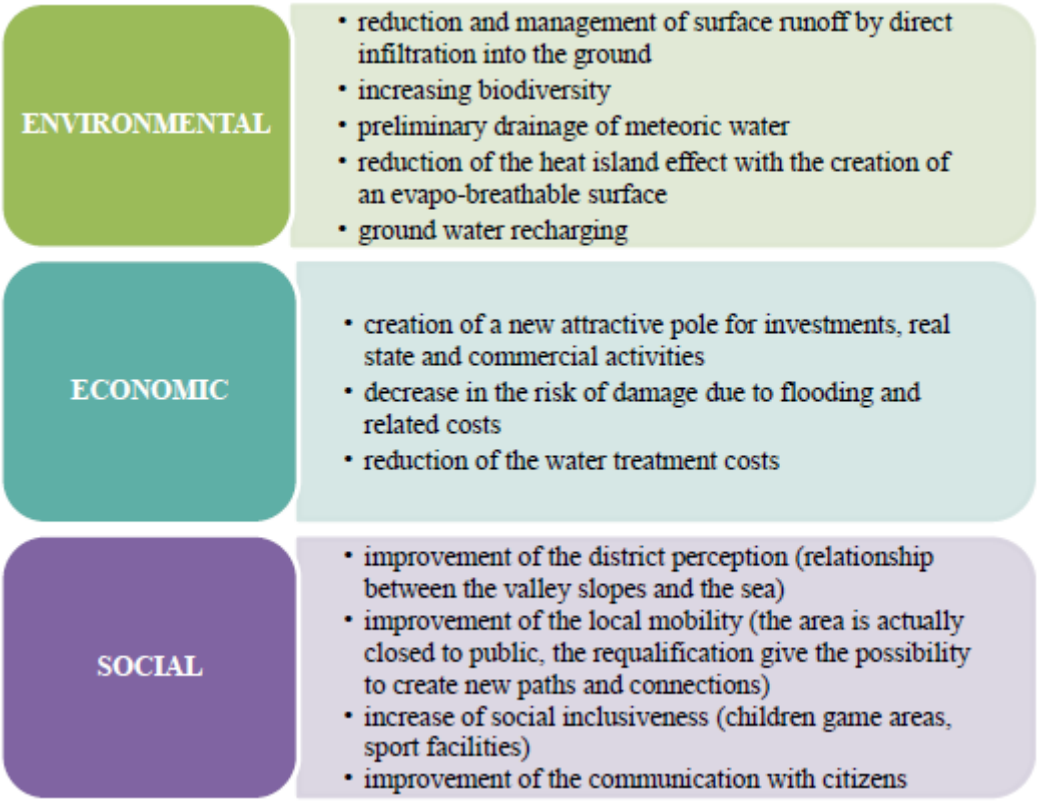

Figure 3: Genoa NBS expected benefits and advantages

Considering the draining surfaces together with the other NBSs implemented within the whole requalification plan (e.g., retention systems, infiltration basins and groups of trees), other additional benefits are expected:

- retaining of runoff waters and rainwater recovery for irrigation
- water saving, drainage of meteoric water, local biodiversity and pollination increasing
- increase of shading area, absorption of CO2, increase of urban quality
- increase of the urban quality and of the citizens' health
- creation of an attractive pole within the city and the district that may attract investments, commercial activities and other general businesses.

1.3 NBS replicabilty: expected drivers and barriers

1.3.1 Possible drivers to NBS replicability

Based on the Genoa experience and considering the initial phase of the project, some possible drivers that can support the implementation, replicability and upscaling potential of the selected NBS have been identified. All the drivers are mainly related to technical, organisational and economic aspects.

- Technical/Organizational drivers

Some technical and organisational aspects can support the implementation of drainage flooring within an urban context:

- climate conditions and the possibility of use open spaces according to seasons;
- design experience in similar urban context about materials and technologies already used, management of the construction site and of the urban traffic and mobility.

- Economic drivers

In addition, some economic drivers have been identified from the Genoa experience in order to support the implementation of draining surfaces also in other urban contexts:

- the possibility of use money savings (e.g., savings coming from maintenance costs) for other citizens' benefits and services;
- the use of NBS is generally less expensive than the use of traditional engineering works;
- come to an agreement with citizens' association for the maintenance of green areas
- increase of the real estate value of the neighbourhood.

1.3.2 Possible barriers to NBS replicability

Few possible barriers could limit the implementation, replicability and upscaling potential of the selected NBS. All the barriers are mainly related to technical, organisational and economic aspects. The implementation of the permeable pavements in the Gavoglio area does not involve any social barriers, for example inhabitants' opposition due to possible disturbances of the construction site. The area is currently closed to public.

- Technical/Organizational barriers

Several technical/organisational aspects can limit the implementation of the draining flooring in urban areas:

- lack of technical operators competence;
- problems related to the habit of use traditional methods;
- stringent hydraulic regulation and building permit procedure;
- lack of communication between the municipality departments in making decisions (e.g. water management department with road department).

- Economic barriers

- high cost related to expected benefits: it is important to compare what exist now in the area and the solution adopted;
- low level of economic cooperation between municipality and private citizens;
- not clearly identification of the foreseen use of the area.

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