LONDON'S GLOBAL UNIVERSITY

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GREEN INFRASTRUCTURE: WATER

A factsheet on urban green and blue space

EngEx GI Factsheet
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Based on EngEx report 'Green Infrastructure for London: A Review of the Evidence'

The Engineering Exchange

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In large cities, changes in land use due to urban development can increase flood risks and water pollution. Sustainable Drainage Systems (SuDS) using green infrastructure-based approaches to drainage can bring solutions to these urban water problems. Traditional, engineered 'grey infrastructure' solutions such as pipes and drains can also be complemented by green infrastructure approaches (Box 2). Green infrastructure approaches can bring additional benefits for biodiversity, air quality and health and wellbeing of local residents.

Box 1: What is Green Infrastructure?

Green infrastructure is a strategic, planned network of natural, semi-natural and artificial plant and water components designed and managed to deliver a wide range of 'ecosystem services' (benefits to environment and people) and quality of life benefits. In an urban setting, green infrastructure may include parks, woodlands, wetlands, rivers, private gardens, street trees, allotments, playing fields, green roofs and sustainable drainage systems.

Benefits and issues: Green infrastructure and water

Conventional piped drainage systems are designed to transport storm water away from streets and homes as quickly as possible, for release to a larger water body like a river or the sea. SuDS techniques can be used to help capture, use, retain, and delay release of rainwater in the location it falls. This is especially useful during a heavy storm event, when surface water runs off of hard urban surfaces (buildings, paths and roads) and fills drains, causing flooding. In many cities storm water flows in the same pipes as sewerage. During heavy storms, dilute sewerage overflows from sewers into local rivers. The process described is called Combined Sewer Overflow (CSO) and is a source of urban water pollution.

Benefits

- **Mimic natural processes:** SuDS have the ability to physically remove and chemically or biologically treat pollutants from storm water runoff using soils and vegetation. The effectiveness of treatment is linked to the speed of water movement, plant species present and the filtration media used etc.
- **Manage surface water to reduce flood risks:** SuDS can control the quantity and speed of storm water runoff, helping to manage the flood 'peak' (the largest flow during a flood event). This can help to delay and reduce sewer overflows and the risk of surface water flooding.
- **Capture and storage:** By incorporating SuDS in the urban drainage system, rainwater can be captured and re-used. This particularly helps to manage high and low water quantities at different times of year.
- **Other benefits:** SuDS can improve the local environment by creating green space. This contributes to wider benefits of green infrastructure, including increasing biodiversity, reducing the urban heat island effect and improving health and wellbeing of residents (see also: 'Green infrastructure: Health and wellbeing' factsheet in this series).

Box 2: Sustainable Drainage Systems (SuDS)

Green roofs and walls	Roofs or walls which are fully or partly covered by plants, supported by a 'substrate' of soil or similar growth media. Green roofs can reduce runoff by directly catching and storing rainwater, as well as by encouraging evaporation. Through a series of physical, biological, and chemical processes, they help to reduce pollutants (sediments, organic compounds, heavy metals) in the rainwater.
Rainwater harvesting	Systems used to collect runoff from roofs or surrounding impervious surfaces in an area, before it reaches the ground. If designed appropriately, runoff can be reduced by 37% to 77% depending on the storage size. Long-term performance of rainwater harvesting systems is excellent. Collected water can be used during dry periods and capacity can be balanced by releasing the water before storms.

Infiltration systems	Trenches or basins designed to temporarily store water runoff while allowing it to infiltrate into the ground. Infiltration devices can contribute to reducing storm water runoff and increasing groundwater recharge.
Porous / permeable surfaces	Built surfaces which allow water to infiltrate across the entire surface material (porous), or in through gaps in the surface (permeable). These surfaces can replace impervious surfaces such as car parks, low-speed roads, paths etc. and reduce the volume and frequency of runoff. They can also treat water pollution. Compared to conventional materials, these surfaces can reduce surface runoff volume and lower and delay 'peaks'.
Filter strips and swales	Vegetated slopes designed to treat runoff from adjacent impervious areas, with filter drains implemented further downstream. Studies on the performance of swales have found an average reduction of water runoff volume from as low as 0% to as high as 87%. For 'peak' flow, different studies reported reductions from 27% to 100%.
Bio-retention systems	Shallow, vegetated landscaped depressions that can reduce runoff rates and volumes and treat pollutants. Correctly designed and maintained bio-retention systems can effectively treat water and remove pollutants.
Detention basins	Vegetated or hard-landscaped depressions designed to store water and sometimes infiltrate it back in to the ground. Easy to construct. Modelled results on the performance of a system of detention basins suggested a 'peak' reduction of 48% to 50%.

Issues

- **Care and maintenance:** For SuDS to be effective they require: long-term planning, careful and rigorous design and implementation, proper maintenance and active management. A lack of proper maintenance may lead to health and safety risks. SuDS systems need to be carefully monitored to maintain their functions and reduce the risk of pollutants being washed back into the environment during severe storm events, or as plants die and decay. Maintenance isn't excessive compared to traditional piped systems, but requires different approaches as SuDS systems contain more soft landscaping features.
- **Fit for purpose:** Not all SuDS techniques are suitable for all sites. An understanding of the ground conditions and common weather conditions throughout the year is needed, as well as the condition of neighbouring landscapes.
- **Value of green infrastructure:** It remains difficult to assign costs and values to services and benefits associated with each green infrastructure feature. While some sustainable drainage benefits are more easily measurable, such as improvement in water quantity and quality, social benefits may be less obvious.

Green roofs and walls	The ability to treat pollutants shows mixed results. Green roofs can become a source of pollution by releasing pollutants such as nitrogen and phosphorus from their growth medium or when fertilized. There is lack of evidence for green walls helping to manage peak water flows during storms.
Infiltration systems	Areas where the water table is close to the surface, or where there are impermeable soils such as London clay, may not be suitable for infiltration measures. Long-term performance is still uncertain. There is limited data on the impact on reducing pollution.
Porous / permeable surfaces	Proper installation and adequate maintenance are important to maintain performance. Surfaces that are not properly installed or maintained are prone to clogging and reduced performance. Performance varies from site to site.
Filter strips and swales	Long-term performance of swales is still uncertain, but it can be assumed that this is negatively affected by clogging as they age and the saturation levels of underlying soils.

What don't we know yet?

- **Costs and benefits across sites:** Separate 'cost-benefit' analysis is needed for each project as this can vary significantly depending on the desired outcomes and the characteristics of the site where SuDS are installed. Factors such as existing contamination, soil conditions, groundwater level can affect the capital cost.
- **Opportunity costs:** 'Opportunity costs' are the economic opportunities missed as the result of choosing alternative courses of action. Conflicts of this type can emerge when green infrastructure approaches are used in areas which are in demand for development or as productive agricultural land. These costs are difficult to estimate because 1) green infrastructure projects are often well integrated into other plans or projects and hard to separate out; and 2) the benefits of green infrastructure may be harder to measure and more variable than the costs.
- **Measuring performance:** A review of several US studies showed large differences in the performance of different green infrastructure components in SuDS for reducing runoff and improving water quality. This review recommended a conservative approach in the estimation of benefits.

Summary

Existing evidence and guidance on the use of SuDS for water management in urban areas highlights a range of challenges and opportunities. Many SuDS provide both water management and water treatment, though there are still issues in measuring direct impacts on either. There is a limited but increasing understanding of the economic and non-economic benefits of green infrastructure in urban water management.

Find out more

This factsheet accompanies a full report. For more details and key references please refer to:

- **'Green Infrastructure for London: A Review of the Evidence'**
  https://www.ucl.ac.uk/engineering-exchange/sites/engineering-exchange/files/ucl-green-infrastructure-for-london.pdf

It is one of a series of factsheets produced by The Engineering Exchange at University College London. Others in this series are:

- **Green infrastructure:** Air quality
- **Green infrastructure:** Health and wellbeing

Other resources on green infrastructure and water

- **London Sustainable Drainage Action Plan. Available at: https://www.london.gov.uk/WHAT-WE-DO/environment/environment-publications/london-sustainable-drainage-action-plan**
- **GLA, 2015a. London Sustainable Drainage Action Plan. [pdf] London: GLA.**
  Available at: https://www.london.gov.uk/sites/default/files/lsdap_final.pdf
- **The SuDS Manual (No. CIRIA C753). CIRIA, London.**
  Available at: https://ciria.sharefile.com/d-s7227335a22e40b6a
- **Susdrain https://www.susdrain.org/**

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