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Source: Pappalardo, V., La Rosa, D., Campisano, A., La Greca, P.(2017). The potential of green infrastructure application in urban runoff control for land use planning: A preliminary evaluation from a southern Italy case study. *Ecosystem Services*. 26(B): 345–354. DOI: 10.1016/j.ecoser.2017.04.015.

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Sustainable urban drainage systems: green roofs and permeable paving compared in southern Italy

A new study has looked at the potential of green infrastructure to compensate for the effects of soil sealing generated by urban development. It investigates how green roofs and permeable paving could contribute to flood mitigation in southern Italy. Using a hydraulic model technique, the researchers found that, in this particular urban case, green roofs were more effective than permeable paving. Policies to promote the adoption of sustainable urban drainage systems (SUDS) by the private sector could thus prove more effective under certain circumstances, and policymakers should look at ways to promote SUDS where suitable.

A worldwide trend in an increase in impervious surfaces (impermeable to water), coupled with precipitation extremes, are contributing to a rise in urban flooding, note the researchers behind this study. Current drainage systems may struggle to cope with the amount of water run-off during heavy rainfall events, which are predicted to increase under climate change[1]. In this study, researchers assessed the effectiveness of green roofs and permeable paving for stormwater management in an urban location in southern Italy.

SUDS refers to a range of drainage technologies that are more sustainable than conventional solutions[2], and may include types of green infrastructure, for example green roofs, permeable surfaces, and purpose-built ponds and wetlands. These techniques use landscape features and natural processes to slow flows of water, increase evaporation and encourage infiltration into the ground. As a co-benefit, SUDS strategies can enhance ecosystem services, such as wildlife habitat, carbon sequestration, recreation and education. Conventional drainage, meanwhile, focuses on channelling water into drainage areas as quickly as possible.

To evaluate the effectiveness of two types of SUDS, the researchers compared three scenarios in the city of Avola, Sicily — an area which underwent rapid urbanisation in the 20th century. First, they identified the amount of land falling into different use categories, for example 'residential-semi-intensive', with less than 50% permeability, 'road and parking areas' and 'bare soil', and obtained plans of the sewer system. Together with rainfall data going back to 1940, these inputs were used with modelling software (the US EPA Storm Water Management Model[3]) to analyse water flows and run-off under each scenario, for a sub-catchment (part of the wider watershed) in the city.

Modelling was conducted over two-, five- and 10-year timeframes, taking into account the number of peak-flow events (e.g. storms) that would be likely to occur during this time, known as a 'return period'. In the first scenario, with no SUDS measures in place, modelling showed that the existing drainage system would not cope adequately with peak flows over five and 10 years — therefore flooding would occur in several places.

In the second scenario, 150 areas of permeable paving, covering 15 m^2 each, replaced impermeable surfaces in public spaces. In the final scenario, green roofs were installed on 110 buildings, covering about 3.3 hectares. These measures were placed upstream of the area that experienced flooding in the non-SUDS scenario.

Continued on next page.

1. Fratini, C. F., *et al*. (2012). Three Points Approach (3PA) for urban flood risk management: A tool to support climate change adaptation through transdisciplinarity and multifunctionality. *Urban Water Journal*, 9(5): 317–331.

2. Fletcher, T.D., Shuster, W., Hunt, W.F., *et al*. (2014). SUDS, LIDS, BMs, WUDS and more – The evolution and application of terminology surrounding urban drainage. *Urban Water Journal*, 12(7): 525–542

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Sustainable urban drainage systems: green roofs and permeable paving compared in southern Italy *(continued)*

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Results showed that green roofs were the most effective at mitigating run-off and flooding, but efficacy depended on the return period considered. Over two-year periods, both permeable paving and green roofs exhibited improvements over the first scenario, and over five years they reduced, but did not prevent, flooding. Green roofs halved the volume of flooding over the 10-year period, while permeable paving only slightly reduced the incidence.

Surface run-off, meanwhile, was reduced from 34.7 millimetres (mm) (non-SUDS) to 34.3 mm (permeable paving) and 30.7 mm (green roofs), in this time period, indicating limited benefits in this category.

The researchers attribute such limited benefits to the small area covered by the SUDS measures and the fact that the area was limited to public space, compared to the large impervious surface area over the whole catchment. They also acknowledge that the SUDS modelled were only designed to achieve a general reduction in run-off peak discharge, to relieve downstream areas during heavy precipitation.

The results are also subject to some uncertainty. There is a lack of field data on the performance of real-life SUDS in southern Europe and the Mediterranean region, but such data would help to improve modelled results. Such validation would also allow urban planners to use this type of model to inform the best positioning of SUDS, say the researchers. The researchers also underline that results obtained from SUDS simulations are strongly dependent on site-specific characteristics of the urban catchment, which limit the possible location of permeable pavements and, therefore, favour green roofs. In this study, the researchers highlight that more substantial mitigation of peak flow was achieved by green roofs, which are located on private buildings, than permeable paving in public areas. This implies that policies incentivising private adoption of SUDS measures are important. Demonstration projects and subsidies may be used to drive adoption, they suggest, as well as compliance-based instruments such as building-code requirements.