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Combining green infrastructure and ground heat exchangers in urban areas

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Ground Source Heat Pump (GSHP) systems are one of the many alternatives that will help to decarbonise the space heating and cooling – especially in residential sector. High capital costs of drilling for borehole heat exchangers and added complexity of space dedication in densely populated urban areas are hindering the market development. We propose combining GSHP systems with Sustainable Drainage Systems (SuDS) for a more efficient heat exchange, which provide opportunities to significantly improve the resilience and sustainability of our built environment. This combined system removes the need to dedicate space to accommodate shallow ground heat exchangers in areas where the unit price of land is high. Furthermore, hydrological conditions prevalent in the substrate of SuDS provide demonstrably beneficial thermo-hydrological interactions. We built an at-scale SuDS component, i.e. a 950-mm high soil column with a diameter of 1800 mm, as a lysimeter setup at the National Green Infrastructure Facility to test the heat injection into the substrate. A range of field testing scenarios (thermal load and cycling) were applied under natural, external ambient conditions. Soil temperature during heat injection was also simulated numerically by solving a transient heat conduction equation with a finite difference modelling scheme. The developed model was validated using measurements from the lysimeter setup which then enabled numerical experiments into the effects of varying hydrological regimes to be performed.