WATER MANAGEMENT

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3 RECOMMENDED INDICATORS OF WATER MANAGEMENT

3.13 Surface runoff in relation to precipitation quantity

3.13.1 Direct measurement

Project Name: UNaLab (Grant Agreement no. 730052), CLEVER Cities (Grant Agreement no. 776604) and GROW GREEN (Grant Agreement no. 730283)

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Runoff coefficient – direct measurement	Water Management
Description and justification	The extent of impermeable surfaces in urban areas is continually increasing as cities develop and expand, due to the construction of buildings, roads, streets, parking lots, etc. A significant consequence is greater runoff in urban areas, which can also lead to flooding. Many factors are affecting the quantity of surface runoff, including soil

	characteristics, land use and vegetative cover, hillslope, and storm properties such as rainfall duration, amount, and intensity (Sitterson et al. 2017). In general, surface runoff is generated in two ways (Yang, Li, Sun & Ni, 2014): through saturation excess, where runoff is generated when the soil becomes saturated (for example after a lengthy period of rainfall); or, through infiltration excess, where runoff is generated when the rainfall intensity exceeds the infiltration rate of water into the soil (for example during a heavy precipitation event when rain falls more rapidly than it can infiltrate the soil).
Definition	Runoff coefficient in relation to precipitation quantities (m^3/s, L/s or depth-equivalent mm)
Strengths and weaknesses	+ Traditional, well-studied method for open channel flow measurement + Scalable for different purposes - Requires judgement in case of equipment malfunction
Measurement procedure and tool	Direct measurement of runoff (and its characteristics) using standard approaches, including weirs, pressure transducers/loggers, tipping-bucket gauges, etc. (e.g., Stovin et al., 2012). Large scale: Weirs, flumes, orifices. Weirs obstruct the flow making the head behind the weir being a function of flow velocity and flow rate though the weir. Flumes are another traditional method for open channel flow measurement in a channel with converging and diverging sections. The operation principle of the flumes is that the water level is higher in the converging section than in the diverging section, and that there is direct relationship between water depth and flow rate (Adkins, 2006). Small scale: tipping-bucket gauges, pressure transducers for discharge monitoring. Tipping-bucket gauges record runoff volumes as numbers of bucket tips per 24-h period. The depth of the daily runoff is then calculated by dividing the volume of daily runoff by the area of the test plot (Armson, Stringer, and Ennos, 2013). Pressure transducers allow for automatic continuous monitoring and data collection at certain intervals (e.g., 1-min) (Stovin, Vesuviano, and Kasmin, 2012).
Scale of measurement	Plot or building scale to district scale
Data source	
Required data	Runoff measurements
Data input type	Quantitative

Data collection frequency	Annually; at minimum, before and after NBS implementation
Level of expertise required	Moderate – ability to evaluate the accuracy of measurements is required (in case of equipment malfunction)
Synergies with other indicators	Direct relation to *Height of flood peak* and *Time to flood peak* indicators
Connection with SDGs	SDG 6 Clean water and sanitation, SDG 11 Sustainable cities and communities
Opportunities for participatory data collection	No opportunities identified
Additional information	
References	Adkins, G.B. (2006). Flow Measurement Devices. Utah Division of Water Rights, Utah. Armson, D., Stringer, P. & Ennos, A.R. (2013). The effect of street trees and amenity grass on -urban surface water runoff in Manchester, UK. Urban Forestry & Urban Greening, 12, 282-286. Stovin, V., Vesuviano, G. & Kasmin, H. (2012). The hydrological performance of a green roof test bed under UK climatic conditions. Journal of Hydrology, 414-415, 148-161

3.13.2 Curve Number method

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Runoff coefficient – Curve Number	**Water Management**
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