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4.16 Peak flow variation

Project Name: Nature4Cities (Grant Agreement no. 730468)

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Peak Flow Variation	**Water Management**
Description and justification	The peakflow is the maximum value of the flowrate due to a given rain event. It indicates how much the discharge in a river or a stormwater network is impacted by the use of NBS. It can be used to : • assess one NBS type benefit • assess the impact of a combination of NBS set on one large catchment
Definition	Peakflow variation is defined by the relative error in peakflow between the peakflow of the catchment with NBS and the peakflow of a catchment without NBS (% (but flowrates are in l/s or l/s/ha (in case of different catchments comparison))).
Strengths and weaknesses	This indicator will directly assess the impact of NBS in the reduction of the flowrate, which peakflow is a characteristic value.

Measurement procedure and tool	This indicator can be calculated as the average value of a sample of peakflows deduced from a rain/runoff time series (typically one year) and may be obtained with observed runoff (if pre- and post- NBS setting is available) or simulated runoff (Nature4Cities, D2.1). Calculation method : measurement and modelling for evaluation of greening scenarios over a defined period Required tool : • hydrological model for NBS scenario evaluation It can be calculated by HYDRUS-1D/2D, URBS, and TEB-Hydro, models respectively at the object, neighbourhood and city scales (Nature4Cities, D2.2). • observations (with and without NBS) Data sources: • Hydrological modelling • Measurement/Monitoring Data required for the estimation of the indicator have to be calculated either from a model, or from monitoring. In case of model estimation, it requires input data provided by national meteorological services (typically rainfall and potential evapotranspiration). In case of model estimation, once meteorological data is available, calculation makes it necessary to run the appropriate hydrological model. Then the indicator can be estimated from the model results by standard software. Nature4Cities built a simplified model for early stage assessement of this indicator called PFVar (Nature4Cities, D2.4). The PFVar highlights the peak flow variation between two stages with or without NBS. It is expressed in percentage and is calculated for Garden and parks, street trees and greenroofs. For the two later, the calculation needs more evaluation. Such a KPI indicates how much the discharge in a river or a stormwater network is impacted by the use of NBS. Based on the study of two spatial scales (catchment and city) by the mean of two different urban hydrological models. The model URBS (Rodriguez et al, 2008) was applied at the catchment scale while the model TEB-Hydro (Stavropulos-Lafaille et al, 2018) was applied at the City scale. An equation is deduced from regression method for each following studied NBS: • Gardens and parks • Street tree scenarios • Green Roofs

	Database used to build the model is composed of data that were collected during the project VegDUD (financed by the French research agency from 2010 to 2013) and measured data from ONEVU (Nantes Urban Environment Observatory) (Nature4Cities, D2.3).
Scale of measurement	☒ City ☒ Neighbourhood/catchment ☒ Object
Data source	
Required data	• Flowrate data (in case of observed coefficient estimation) in pre- and post-NBS setting • Simulated flowrates (in case of simulated coefficient estimation)
Data input type	Quantitative
Data collection frequency	It can be calculated before an urban planning option in order to evaluate its impact
Level of expertise required	Easy to calculate but requires data. This indicator reveals a potential indirect effect. Both decision makers and citizens are probably not familiar with this indicator and needs to be trained.
Synergies with other indicators	Synergies with other hydrological modelling indicators and greenspace mapping indicators.
Connection with SDGs	
Opportunities for participatory data collection	
Additional information	
References	Rodriguez, F., Andrieu, H., Morena, F., 2008. A distributed hydrological model for urbanized areas – Model development and application to case studies. J. Hydrol. 268– 287. https://doi.org/10.1016/j.jhydrol.2007.12.007 Stavropulos-Laffaille, X., Chancibault, K., Brun, J.-M., Lemonsu, A., Masson, V., Boone, A., Andrieu, H., 2018. Improvements of the hydrological processes of the Town Energy Balance Model (TEB-Veg, SURFEX v7.3) for urban modelling and impact assessment. Geosci. Model Dev. Discuss. 1–28. https://doi.org/10.5194/gmd-2018-39 Nature4Cities, D2.1 - System of integrated multi-scale and multi-thematic performance indicators for the assessment of urban challenges and NBS. https://www.nature4cities.eu/post/nature4cities-defined-performance-indicators-to-assess-urban-challenges-and-nature-based-solutions

	Nature4Cities, D2.2 - Expert-modelling toolbox Nature4Cities, D2.3 – NBS database completed with urban performance data https://www.nature4cities.eu/post/applicability-urban-challenges-and-indicators-real-case-studies Nature4Cities, D2.4 - Development of a simplified urban performance assessment (SUA) tool

4.17 Flood peak reduction and delay

Project Name: CONNECTING Nature (Grant Agreement no. 730222)

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Flood peak reduction/delay (Applied and EO/RS combined)	**Water Management**
Description and justification	NBS can help tackle flood risk, for instance by increasing infiltration and evapotranspiration. Changing precipitation patterns due to climate change are expected to exacerbate flooding problems, for instance more intense rainfall events that exceed existing sewage system capacity. Applied approaches to flood peak reduction/delay include monitoring of SuDS performance using in-situ gauges. Typically, a weather station or weather radar data is used in combination with flowrate or water depth monitoring devices (e.g., datalogging v-notch weirs, tipping bucket rain gauges, in-line turbine flowmeters, depth sensors, soil moisture sensors, and infiltrometers). The weather data is used to calculate total rainfall entering the study area (e.g., rainfall depth/unit time x catchment area). Monitoring devices are then used to calculate the rate that water enters and/or leaves a nature-based solution feature. If compared to a control feature (without nature-based solution) or a baseline calculated for the site before the nature-based solution was installed, it is possible to calculate the percentage reduction in absolute height of peak floodwaters and the delay to peak flow. Remote sensing and GIS technologies coupled with computer modelling are useful tools for examining flood events in comparison with flood extent obtained for the annual rainfall using HEC-HMS and HEC-RAS. Using remote sensing data with the help of Flood Hazard Maps for different return periods (10, 20, 50 and 100 years) it is possible to develop, demonstrate and