International Doctorate in Civil and Environmental Engineering

Investigating hydrological parameters for Nature Based Solutions characterization

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Abstract

Sustainable urban Drainage Systems (SuDS), by themselves or combined with grey traditional infrastructures, help to diminish the runoff volume and peak flow, as well as water quality improvement. Hydrological design of SuDS is usually based on rainfall percentiles to be managed, and following different criteria, as the number of rainfall events to be managed, Nx, or the accumulated volume of the rainfall series to be managed, Vx. Sub-index x refers to the percentage (number or volume) to be managed, being the most common values 50, 80, 85, 90, 95%. Usually, only daily rainfall data are available. Nevertheless, due to the small dimensions of the urban watershed involved in the SuDS implementation, the quantification of design parameters for these facilities needs sub-hourly rainfall series. To overcome this issue, we applied a temporal downscaling methodology using a stochastic rainfall generator model (RainSim V3). We analyzed the case of Florence University rain gauge (Tuscany, Italy, Code TOS01001096), by collecting 20 years (1998-2018) of observed data at 15 minutes time step. First, we verified the ability of RainSim model to reproduce observed rainfall patterns at 15 minutes time-step, but estimating the model parameters from observed daily data. We obtained a better characterization of the rainfall regime by applying the downscaling methodology than using daily-observed data. We generated 1000 series of 20 years each (from 1998 to 2018) with a time step of 15 minutes. We accounted two variables to implement the storm events extraction: a) the minimum Antecedent Dry Weather Period (ADWP) between storm events; 2) the rainfall volume threshold to consider a storm for the analysis. Second, we compared the SuDS design parameters Nx and Vx, obtained by applying the stochastic procedure, using observed daily and 15 minutes data. Moreover, the effect of different ADWPs and Thresholds on Nx and Vx were evaluated. In both cases, results show that the median of the simulated Nx and Vx series are closer to the actual observed parameters based on 15 minutes time step, than the observed 24 hours aggregated rainfall data. Therefore, the proposed downscaling method arises as an efficient technique to overcome the lack of sub-hourly rainfall data, necessary to adequately design SuDS.