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Rainfall temporal variability and rainwater harvesting efficiency: an analysis over the Italian territory.

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Rainwater harvesting for indoor uses could be a useful practice for a sustainable management of urban water. The realization of a rainwater harvesting system strictly depends on the costs and the required space so that an accurate design is necessary, especially in the tank sizing step. The volume of the tank is an important element of the system which impacts not only important environmental issues such as the volumes of saved potable water and the reduction of rainwater volumes to the sewerage system, but also the costs and the practical realization of the rainwater harvesting system. Nevertheless, while the professional world seeks solutions that are easy to apply (e.g. simplified sizing methods), from a scientific point of view several aspects are still to be clarified, among these the role of the temporal variability of rainfall in the tank sizing step, that is the object of the present study.

Rainfall temporal variability is quantified by the Coefficient of Variation (CV) of rainfall datasets. This analysis is carried out through numerical simulations and it is focused on the national Italian territory. Daily rainfall data of 3436 rainfall gauge stations located on the national Italian territory are considered and buildings with different catchment area and number of persons are taken into account. Our computations show that the majority of rainfall gauges in Italy has a rainfall CV in the 2.5-3.5 range, with higher values in the South and in the main islands. The role of the temporal variability of rainfall is clear: the same building in locations with the same mean annual rainfall depth, can require different tank sizes according to the rainfall coefficient of variation of the specific location. As an example, to reach the same water saving, a medium rise building located in Ascoli Satriano (CV=2.42) should be equipped with a tank size of 2700 litres, while in other locations which have the same mean annual rainfall depth but different CV, like Casale Monferrato (CV=3.41) and Muravera (CV=4.83), the required capacity is 3400 litres and 6800 litres, respectively. This underline the importance of taking into account the rainfall temporal variability in the tank sizing.

The analysis made use of non dimensional parameters, i.e. the storage fraction and the demand fraction, so that the results, obtained from different buildings over the Italian territory, are comparable, allowing in this way to build a unique graph that contains all information: the water demand, the mean annual rainfall depth and the rainfall coefficient of variation, as well as the number of inhabitants and the roof area of the building.