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Evaluating residential water consumption at high spatio-temporal level of detail: a Dutch case study

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Due to population growth, urbanization, and climate change, it is nowadays necessary to go for an ever-more adequate management of water resource in order to satisfy current and future demand. In this regard, an accurate estimation of water consumption is helpful for the implementation of strategies aimed at developing efficient water systems [1]–[2]. Strategic assessments are often carried out with the support of predictive or descriptive demand models (e.g. [3]). However, when no observed data are available, these models have to be parameterized according to predefined parameters distributions (e.g. probability distribution of duration, volume, flow rate of each end use), but the availability of this kind of information derived by field observation is rather limited.

The current study aimed at exploring the characteristics of water consumption at nine households – different in terms of occupancy rate and end-uses – located north of Amsterdam (The Netherlands), in which smart monitoring of water consumption at 1-s temporal resolution with 0.1 L/pulse accuracy started in 2019. The aggregate water consumption observed at each household was automatically disaggregated into individual end-use events, which were then manually classified by expert analysts based on the responses of water use questionnaires subjected to household occupants. Specifically, more than 64,000 events registered over about 445 days of monitoring were labelled in five categories of indoor water use: dishwasher, washing machine, faucets, shower/bathtub, and toilet.

Statistical analyses were then conducted for each household in order to evaluate: i) the daily per capita end-use water consumption; ii) the end-use parameter values (i.e., duration, volume, flow rate, per capita daily frequency) and their main statistical properties such as mean, variance, and probability distributions. On the one hand, the results confirmed that, on average, the largest components of the daily residential water consumption were related to the use of showers/bathtubs and toilets (43 and 30 L/person/day, respectively), followed by washing machines, faucets, and dishwashers (16, 14, and 3 L/person/day). On the other hand, the largest average volumes per event were tied to showers/bathtubs and washing machines (64 and 63 L/use), while the highest average frequency of use was observed for faucets and toilets (14 and 4

uses/person/day). Moreover, different parameter distributions were estimated, depending on the end-use and the parameter considered.

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