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A framework for cost-effective enrichment of water demand records at fine spatio-temporal scales

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Residential water demand is a key element of urban water systems, and hence its analysis, modelling and simulation is of paramount importance to feed modelling applications. During the last decades, the advent of smart metering technologies has released new streams of high-resolution water demand data, allowing the modelling of demand process at fine spatial (down to appliance level) and temporal (down to 1 sec) scales. However, high-resolution data (i.e., lower than 1 min) remains limited, while longer series at coarser resolution (e.g., 5 min or 15 min) do exist and are becoming increasingly more available, while the metering devices with such sampling capabilities have potential for a wider deployment in the near future. This work attempts to enrich the information at fine scales addressing the issue of data unavailability in a cost-effective way. Specifically, we present a novel framework that enables the generation of synthetic (yet statistically and stochastically consistent) water demand records at fine time scales, taking advantage of coarser-resolution measurements. The framework couples: a) lower-scale extrapolation methodologies to provide estimations of the essential statistics (i.e., probability of no demand and second-order properties) for model's setup at fine scales, and b) stochastic disaggregation approaches for the generation of synthetic series that resamples the regime of the process at multiple temporal scales. The framework, and individual modules, are demonstrated in the generation of 1-min synthetic water demands at the household level, using 15 min data from the available smart meter.