Inclusion of climatic and touristic factors in the analysis and modelling of the municipal water demand in a Mediterranean region

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In Mediterranean regions, inherently affected by water scarcity conditions, the gap between water availability and demand may further increase in the near future due to both climatic and anthropogenic drivers. In particular, the high degree of urbanization and the concentration of population and activities in coastal areas is often severely impacting the water availability also for the residential sector. It is therefore crucial analysing the importance of both climatic and touristic factors as drivers for the water demand in such areas, to better understand and model the expected consumption in order to improve the water management policies and practices.

The study presents an analysis referred to a large number of municipalities, covering almost the whole Romagna region, in Northern Italy, representing one of the most economically developed areas in Europe and characterized by an extremely profitable tourist industry, especially in the coastal cities.

For this region it is therefore extremely important to assess the significance of the drivers that may influence the demand in the different periods of the year, that is climatic factors (rainfall depths and occurrence, temperature averages and extremes), but also the presence of tourists, in both official tourist accommodation structures and in holidays homes (and the latter are very difficult to estimate).

Analyses on the Italian water industry at seasonal or monthly time scale has been so far, extremely limited in the literature by the scarce availability of data on the water demands, that are made public only as annual volumes. All the study municipalities are supplied by the same water company, who provided monthly consumption volumes data at the main inlet points of the entire distribution network for a period of 7 years (2009-2015). For the same period, precipitation and temperature data have been collected and summarised in indexes representing monthly averages, days of occurrence and over threshold values; in addition, information on the tourist flows, at monthly scale, have been collected and processed.

Such data have been validated and aggregated at municipal or multi-municipal scale and are analysed, in particular in reference to a severe dry period occurred in 2011-2012, in order to understand the demand pattern and the users' response to a water scarcity condition, examining the influence of the different climatic and anthropogenic (touristic) drivers on the water demand.

Finally, a non-linear model, based on a neural network architecture, was implemented for each municipality, for simulating the monthly water demand as a function of previous demands and of the identified climatic and touristic indexes: the outcomes of the models demonstrate the added value of the addition of determinants based on both climatic and touristic data and such value, as expected, is higher for the coastal municipalities, having a higher tourist vocation.