SHORT TERM WATER CONSUMPTION FORECASTING IN THE METROPOLITAN AREA OF SAO PAULO

Claudia Cristina dos Santos[1] and Augusto José Pereira Filho[2]

[1]National Institute for Space Research - INPE / DSR, Av. Astrounatas, 1758, Jardim da Granja São José dos Campos, SP 12227-010, Brazil
[2]University of Sao Paulo - Sao Paulo - USP / DCA, Rua do Matão, 1226, São Paulo, SP 05508-900, Brasil São Paulo, SP 05508-900, Brazil

ABSTRACT

The water supply and distribution operation systems are the principal components of water consumption. The operation of these systems requires frequent adjustments in response to variations in demand in order to minimize the distribution costs. The demand varies along the time. For example, it depends on the time of day, the day of week, the month and the season. These variations may be affected by the weather, holidays and domestic and industrial activities (Mukhopadyay et al., 2001).

Demand forecasting is also an important factor for the management of water consumption, especially when you intend to create or expand a urban water supply system. There are various methods of demand forecasting, however, methods that use Artificial Neural Networks - ANN are still few in literature (Adamowski, 2008, MingQi, 2009).

The main motivation for the use of ANN is the need to develop models for forecasting water demand for urban water supply systems with specific methodologies for forecasting problems in Brazil, specifically for the Metropolitan Area of Sao Paulo (MASP). Therefore, the study of the main effects of socio-environmental and meteorological variables and the performance of the use of Artificial Neural Network (ANN) are the main motivations in this paper. The paper aims to forecast the water demand in urban water supply systems, using the technique of artificial neural networks to obtain more reliable and accurate short term forecasting.

A network of three layers was undertaken with the input vectors, the water consumption in the last 24 hours, precipitation, humidity, pressure, temperature, and the other variables that may influence the consumption, being the output vector water consumption, hourly or daily. The variables were normalized (Lachtermacher e Fuller, 1995) due to the difference between these units. Normalization was in the range between 0 and 1. The total data, 70% were used to train the ANN and the remaining 30% to test and verify.

After analyzing the data, the first processing performed was the normalization (preprocessed) of the input data for the training, the testing and the prediction of ANN. The results obtained were denormalized (postprocessed). The values of N, the total number of samples or standards contained in the training set is variable according to the period of data. The series of input and output identified were classified as attributes with real values as they are variables of the consumption, meteorological and time.

The data utilized was of the year 2005. The Cantareira system was chosen because it is the main production system in MASP and the Itaim Paulista, because it is an area that is predominantly residential.

The results show that the ANN for great systems such as Cantareira water treatment station (WTS) on prediction results obtained using the average consumption of 1 hour, do not lead to

good results. It was observed that when the memory was used for the mean data and forecasting of 1 hour, the results were slight. The best results were used to model the average 12 hours and variables memory. It was observed that when using the system memory, the results improved. It may consider that the models showed good predictions and may be used to predict the Cantareira WTS, and get a good result for decision making regarding the use of water for 12 hours ahead. Then, it is recommended, for a system such the as Cantareira WTS, the use of ANN for consumption forecasting, where the prediction is done for 12 hours ahead.

Various tests of ANN for consumption forecasting in Itaim Paulista area were realized. The first tests showed the same characteristics except the number of hidden layers. It was observed that increasing the hidden layers did not improve the fitness of the curve in relation to the observed data, but the training and forecasting there was an improvement. Thus, due to the increase seen in the processing time this improvement is not worth, but it is better to keep one hidden layer for the other models.

It was observed that the memory system is an important factor for prediction. For short term periods, it is easier to obtain better results for a minor system than for bigger one. In this case, it is recommended to forecast for a longer period. The hourly prediction was achieved with acceptable error rates, and comparing the results of every case, there is the same trend for every, minor error. These results may help in the operation of the system used in conjunction with weather forecast models.

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