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Investigating Effect of the Preprocessing of the Data on the Accuracy of the Modeling Solid Waste Generation through ANNs

M. Falahnezhad[1], M. Abdoli[2*]

1- Ph.D. Student, Department of Civil and Environmental Engineering, Tehran University
2- Professor, Department of Civil and Environmental Engineering, Tehran University

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ABSTRACT

Waste generation in today industries is a serious problem. Waste generation from the production stage to the final disposal is an inevitable issue. Development of the cities and the industrialization cause the everyday increase in solid waste generation. Therefore, knowing the waste values is an essential tool for the solid waste management systems. In this research, artificial neural network is used as a financial tool for modeling the solid waste generation in Mashhad. For this purpose, first, some pre-processing on the dependent and independent variables are done and the effect of this procedure on the accuracy of the model is investigated. Research findings clearly indicate that by / through using some preprocessing on the input data, accurate results can be obtained. Three different conditions have been evaluated and the best one is selected which contains logarithm, trend removing and standardizing. The selected network has two hidden layers with five neurons in each one. Network performance parameters are MAPE, MSE and R^2 that equal to 0.06, 0.46 and 0.86, respectively.

KEYWORDS

Municipal Solid Waste, Artificial Neural Network, Preprocessing, Mashhad.

* Corresponding author, Email: mabdoli@ut.ac.ir

1- INTRODUCTION

MSW is a natural consequence of human activities. Collection, transportation and disposal of the municipal solid waste are significant issues in the waste management. If the system is not handled properly, these chemicals cause environmental pollution and endanger the human health. Estimation of the waste generation is a significant issue due to the various factors affecting on the waste production. Since waste management system needs prolonged plan, being aware of waste quantity in future is so important. Noori et al used SVM model with PCA technique in order to model the municipal waste and forecasting waste generation [1].

Bigel et al used different scenarios using least square method to estimate the effect of GDP, infant mortality, life expectancy and population gains on Europe waste products in cities. The resulting model R^2 and percentage absolute error are yielded 65% and 8%, respectively [2]. R^2 and error rate indicate that the model is sufficient to describe the amount of waste produced. Considering the importance of waste generation in future, in this paper, the effect of socio economic and climatic variables are assessed and long term forecasting of waste generation in future (22 years later) using ANN is conducted.

2- METHODOLOGY, DISCUSSION, RESULTS

The purpose of this study is to provide a convenient and reliable method for obtaining the long-term rate of production of urban waste, to decide for the future amount of waste. Therefore, MSW production variables such as socioeconomic and climatic variables should be considered in future MSW generation.

To investigate the possibility of predicting the long-term waste production with the neural networks, three different cases are examined: at first, the time series data without any pre-processing of input and output variables are considered. Then, the trends in time series data in inputs and outputs are removed. In the third case, the logarithm of input and output data is taken and these time series are used in the modeling procedure. The three cases are discussed in this study. Then, the performance parameters are compared with each other in the three models.

Case study

Mashhad is a major city in the north east of Iran. Its area is around 204 km^2 and its population in 1385 was 2410800. Therefore, this city is the second populated city in Iran.

Artificial neural network

Anns have the ability to model the linear and nonlinear relationships. Some of the features of ANNs are learning ability, generalization, parallel processing and etc. With regard to the nonlinear waste generation, ANN is a good idea to propose in this field.

The function, which is used in this article, is:

$$Sw = f(I, P, MT)$$

Which:

I: income

P: population

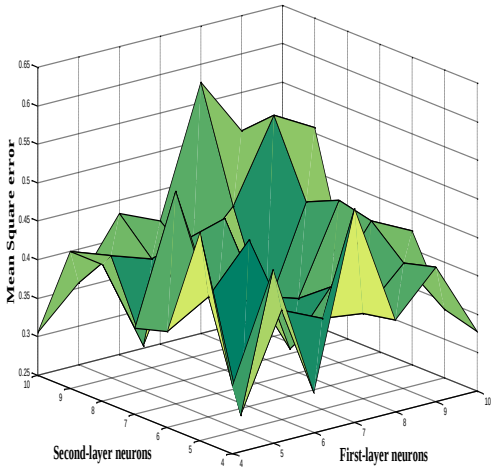
MT: average temperature

As mentioned above , three different conditions have been assessed in this study and the obtained results are as follows:

Case 1: Ann structure with two hidden layer with five and six neurons in each one. R^2 achieved 0.74 and Mape is 0.06

Case 2: Ann structure with two hidden layer with nine and ten neurons in each one. R^2 achieved 0.79 and Mape is 0.05.

Case 3: Ann structure with two hidden layer with five and five neurons in each one. R^2 achieved 0.86 and Mape is 0.046.



This figure indicates the R^2 changes with neurons in hidden layers.

3- CONCLUSIONS

Since the neural networks have interpolating characteristic and can be trained in the range of input data, so they cannot forecast the values which exist out of this range. To solve this problem, we tried to get close to the stationary state to scale input and output data in the training phase. Therefore, by eliminating the trends, predictions based on the random elements are done. In addition to an increased accuracy, using the logarithmic model causes stationary state. The results showed that the logarithm of the time series variable in input and output data make more accurate model.

4- REFERENCES

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