

Aquaculture Congress 2020: Prediction of environmental indicators in land leveling using artificial intelligence techniques- Isham Alzoub- University of Tehran

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Abstract

Land levelling is one of the most important steps in soil preparation and cultivation. Although land leveling with machines require considerable amount of energy, it delivers a suitable surface slope with minimal deterioration of the soil and damage to plants and other organisms in the soil. Notwithstanding, researchers during recent years have tried to reduce fossil fuel consumption and its deleterious side effects using new techniques such as; Artificial Neural Network (ANN), Imperialist Competitive Algorithm –ANN (ICA-ANN), and regression and Adaptive Neuro-Fuzzy Inference System (ANFIS) and Sensitivity Analysis that will lead to a noticeable improvement in the environment. In this research effects of various soil properties such as Embankment Volume, Soil Compressibility Factor, Specific Gravity, Moisture Content, Slope, Sand Percent, and Soil Swelling Index in energy consumption were investigated. The study was consisted of 90 samples were collected from 3 different regions. The grid size was set 20 m in 20 m (20*20) from a farmland in Karaj province of Iran. The aim of this work was to determine best linear model Adaptive Neuro-Fuzzy Inference System (ANFIS) and Sensitivity Analysis in order to predict the energy consumption for land leveling. According to the results of Sensitivity Analysis, only three parameters; Density, Soil Compressibility Factor and, Embankment Volume Index had significant effect on fuel consumption. According to the results of regression, only three parameters; Slope, Cut-Fill Volume (V) and, Soil Swelling Index (SSI) had significant effect on energy consumption. Using adaptive neuro-fuzzy inference system for prediction of labor energy, fuel energy, total machinery cost, and total machinery energy can be successfully demonstrated. In comparison with ANN, all ICA-ANN models had higher accuracy in prediction according to their higher R² value and lower RMSE value. The performance of the multivariate ICA-ANN and regression and artificial neural network and Sensitivity analysis and Adaptive neuro-fuzzy inference system (ANFIS) model was evaluated by using statistical index (RMSE, R²). The values of RMSE and R² derived by ICA-ANN model were, to Labor Energy (0.0146 and 0.9987), Fuel energy (0.0322 and 0.9975), Total Machinery Cost (0.0248 and 0.9963), Total Machinery Energy (0.0161 and 0.9987) respectively, while these parameters for multivariate regression model were, to Labor Energy (0.1394 and 0.9008), Fuel energy (0.1514 and 0.8913), Total Machinery Cost (TMC) (0.1492 and 0.9128), Total Machinery Energy (0.1378 and 0.9103). Respectively, while these

parameters for ANN model were, to Labor Energy (0.0159 and 0.9990), Fuel energy (0.0206 and 0.9983), Total Machinery Cost (0.0287 and 0.9966), Total Machinery Energy (0.0157 and 0.9990) respectively, while these parameters for Sensitivity analysis model were, to Labor Energy (0.1899 and 0.8631), Fuel energy (0.8562 and 0.0206), Total Machinery Cost (0.1946 and 0.8581), Total Machinery Energy (0.1892 and 0.8437) respectively, respectively, while these parameters for ANFIS model were, to Labor Energy (0.0159 and 0.9990), Fuel energy (0.0206 and 0.9983), Total Machinery Cost (0.0287 and 0.9966), Total Machinery Energy (0.0157 and 0.9990) respectively, Results showed that ICA-ANN with seven neurons in hidden layer had better.

Methods

New techniques such as ANN, ICA, GWO-ANN, PSO-ANN, sensitivity analysis, regression, and ANFIS that using them for optimizing energy consumption will lead to a noticeable improvement in the environment. In this research, effects of various soil properties such as embankment volume, soil compressibility factor, specific gravity, moisture content, slope, sand percent, and soil swelling index in energy consumption were investigated. The study was consisted of 350 samples which were collected from 175 regions in two depths. The grid size was set 20 m × 20 m from a 70-ha farmland in Karaj province of Iran.

Results

The model that reveals the relationship between the land parameters and the energy indicators were extracted. As it was expected three parameters; density, soil compressibility factor and, embankment volume index had significant effect on fuel consumption. In comparison with ANN, all ICA-ANN models had higher accuracy in prediction according to their higher R² value and lower RMSE value. Statistical factors of RMSE and R² illustrate the superiority of ICA-ANN over other methods by values about 0.02 and 0.99, respectively. Results also revealed the superiority of integrated techniques over other methods for prediction of complicated problems such as land leveling energy estimation.

Conclusion

Results were extracted and statistical analysis was performed, and RMSE as well as coefficient of determination, R², of the models were determined as a criterion to compare selected models. According to the results, 10-8-3-1, 10-8-2-5-1, 10-5-8-10-1, and 10-6-4-1 MLP network structures were chosen as the best arrangements and were trained using

Levenberg–Marquardt as NTF. Integrating ANN and imperialist competitive algorithm (ICA–ANN) had the best performance in prediction of output parameters, i.e., energy indicators.

Note: This work will be partly presented at Aquaculture and Marine Biology Webinar during July 20, 2020