Suspended sediment prediction in Kebir watershed, northeast of Algeria

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Key words geomorphology, ANN, regression, prediction, suspended sediment modeling.

The objective of this research was to identify potential equivalences between artificial neural networks and statistical regression and to verify these equivalences when applied to modeling sediment loads in the Kebir river, located in the northeast of Algeria. The watershed (681 Km²) has shown a construction of two reservoirs, Mexa (Algeria) and Barbara (Tunisia) in 1999 (Figure 1).

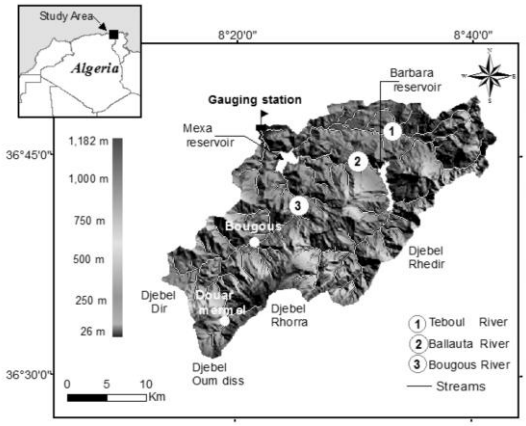

Figure 1. Location map of the Kebir watershed.

Basically, the river discharge (Q) and suspended sediment concentration (C) data were based on daily measurements. In this regard 129 daily data sets have been collected over 20 years (1979 to 1999). First, the sediment rating curve (SRC) was used as a power function of the form [1]: C or $Qs = aQ^b$; Qs is the sediment discharge (product of Q and C).

In designing MLP and Lm, the input combinations were covering the geomorphological parameters and the target layer was consisting of the unique sediment load data and the expression could be written in the mathematical form for ANN model given by following equation: $Qs = fcn\ (Q^{\sqrt{Dd}}, Q^{\sqrt{Sf}}, Q^{\sqrt{S}}, Q^{\sqrt{Li}}, Q^{\sqrt{Fi}})$; where Dd is the drainage density, Sf is the shape factor of the basin, S is the mean basin slope, Li is the lithologic index, and Fi is the forest cover. Before training, the data sets have been normalized and then divided into three parts as: training, testing and validation [2]. *RMSE* (root mean squared error) was noted for each analysis and cross validation was also performed to estimate R^2 values. The model efficiency factor *EF* of observed and predicted values were also estimated for different predictions on validation datasets.

Based on the measured paired values of Q and Qs data from the training subset, SRC model has given $R^2 = 0.89$. The developed regression underestimated the true sediment load by – 14.90% and had a model efficiency (*EF*) of 0.88. The normalized *RMSE* value found equal to 0.069 was in acceptable range. The MLP and Lm methods provided better performance in sediment estimation compared to SRC. Values of R in the training phases were higher with coefficients of correlation equal to 0.96 and 0.97, *RMSE* ranged from 0.040 to 0.054 and *EF* varied between 0.91 and 0.94. The Lm best network for the testing period was provided by the nine neuron model in the hidden layer, with a slight underestimation of only -0.48. As a conclusion, we can say that the use of the three-layered ANN structure with the number of neurons in hidden layer via Levenberg-Marquardt algorithm (Lm) has improved the simulation results and the performance of the developed models for prediction of sediment load found very satisfactory on the basis of statistical indices.

References

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