GEOMORPHO MODELLING PROCESSES USING ARTIFICIAL NEURAL NETWORKS

Conf.dr,.PhD. LEVENTE DIMEN,
"1 Decembrie 1918 " University, Alba Iulia, Romania

ABSTRACT: *The erosion is one of the most important problem in the study area of Zlatna basin. Due to this problems of the landfill erosion -it becomes necessary to analyze some factors according to this pattern. In the present paper we intend to establish some methods whom results which will be used as base in the erosion assessment. For an estimation of erosion for this area we were using as indicator the specific discharge of alluvial soil from the main collector of the area's hydrographic system, the average water discharge - as outputs and the precipitation's -as inputs of the system.*

Using neuronal networks our aim is to establish a model which is helpful in the estimation and forecasting the evolution of the factors which determine the dynamic and efficiency of the erosion. This main factors are the average water discharge and the average water discharge.

As it follows we wish to present some spatial data related to the study area and the methods and results using this black box model, in forecasting the most essential factors.

Keywords: *estimation erosion, methods, indicator, neuronal networks.*

1. The study area

Pollution problems are most severe in the Zlatna basin where they are accentuated considerably by the climatic conditions.

The depression has a tectonic origin but is also modelled by actions associated with marine retreat, evidenced through Miocene formations. It lies between three sub-units of the Apuseni Mountains with Trascau Massif to the north, the Muntii Vintului to the south and the Muntii Auriferi to the west.

The basin has a population of 9,800 of whom some 4,450 live in the town. The main employers are the mining company 'Exploatarea Miniera Zlatna' (with 1,130 employees including the ore preparation plant) and the Ampellum enterprise - producing electrolytic copper, sulphuric acid and alumina (atomised aluminium particles used for paint preparation). from complex ores - accounts for another 2,500. All this activity derives from volcanism in the southern part of the Apuseni Mountains and the resulting mineral endowment of copper, gold and silver ores exploited since Roman times (although processing did not start until 1747).

The wind comes predominantly from the west and northwest so that pollution - quite moderate at first - is directed down the valley. However, it is clear from historic paintings of the area that pollution was aggravated by the lack of a normal wind flow due to the containment of the air in the basin under a 300m high inversion belt. Inversions are most frequent at night and during cold periods, especially in spring. Hence the greatest air pollution is found below this level at a distance of up to four kilometres to the southwest.

The local topography - was damaged through the horizontal dispersion of gases; adversely affecting human health and the ecosystems in general, especially the lower slopes of the depression below the town which have suffered heavy erosion.

Pollution is greatest during periods of calm when the stagnant air is highly contaminated and causes great damage to the vegetation. High pollution correlates with cloudiness and high humidity: nebulosity reduces the penetration of solar energy. Heavy metals, gases and dust damage the soil and prevent natural regeneration. Rain is important in washing pollutants into the soil and removing the unprotected soil particles into the gully systems and afterwards into the main collector of the area which is the Ampoi river.

Due this fact soils have been excessively degraded over some 30,000ha offering a landscape of bad lands.

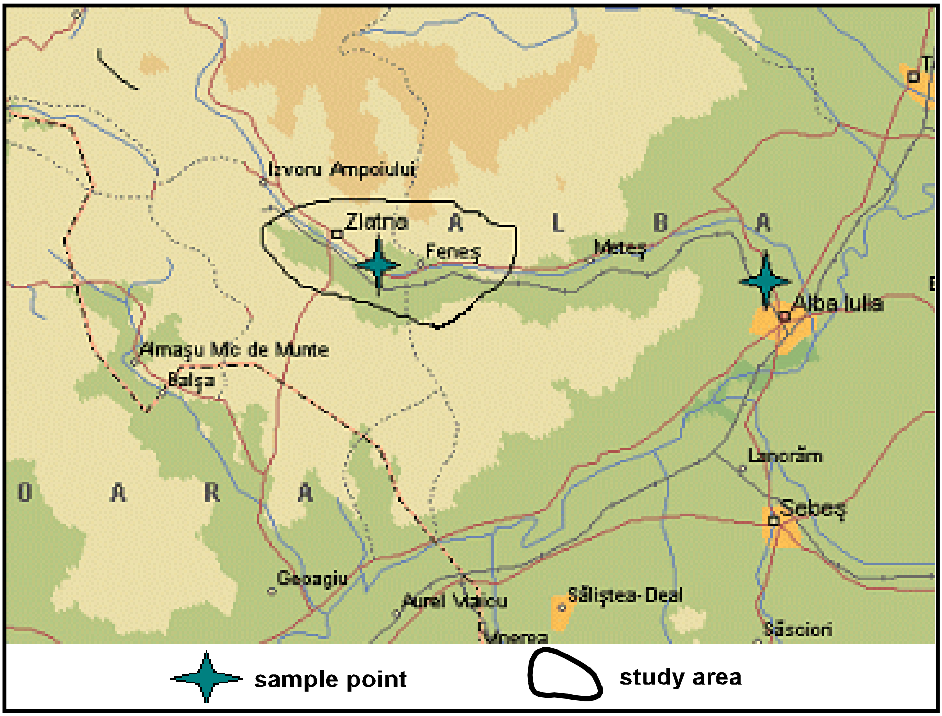

Fig. 1. The study area

2. Neural aproaches in system modelling and prediction

The identification of a system implies the finding of a class of functions (or models) that could approximate the behaviour input-output of the system in the best way possible. The best way is usually defined in the terms of a cost function. In many situations, such as the recognition of the temporal sequences, dynamic systems identification etc., the output of the modelling system depends on the passed inputs and outputs. When the modelling is done by way of neural networks, it is necessary for them to have a memory that takes into consideration these dependencies. In the paper [9] it is shown that the problem of learning between an input space and an output space is equivalent to the process of synthesizing of an associative memory.

Another approach uses feed-forward neural networks (without memory) but “alimented” with delayed outputs and inputs, dependent on the modelled system order. [10].

The question is if the system dynamics could be included directly in the network structure, so that dynamic systems could be modelled without knowing much about them. Feed-forward neural networks, equipped with a form of memory by means of an external delaying line, were used successfully for the identification and modelling of some processes or non-linear dynamic systems.

Next, we consider the system represented by the model NARX (Non - Linear-Auto-Regressive with eXogenous inputs).

$$x(k)=f(X(k-1),U(k-1))+w(k) \quad (1)$$
$$y(k)=x(k) \quad (2)$$

where:

-X(k-1)=[x(k-1), x(k-2),..., x(k-n)]

-U(k-1)= [u(k-1), u(k-2),..., x(k-M)]

-x(k) is system state at time k, y(k) is system output at time k, u(k) is system input at time k, w(k) is the noise, k represents the discrete time

-M and N are the delay orders for the inputs and the states.

The figure below illustrates:

-the model of the system (a), and

-the neural network that simulates the system (b).

In the following section we describe the results obtained with such a neural network, trained to model a dynamic system, with a view to determine the prognosis of the real system behaviour.

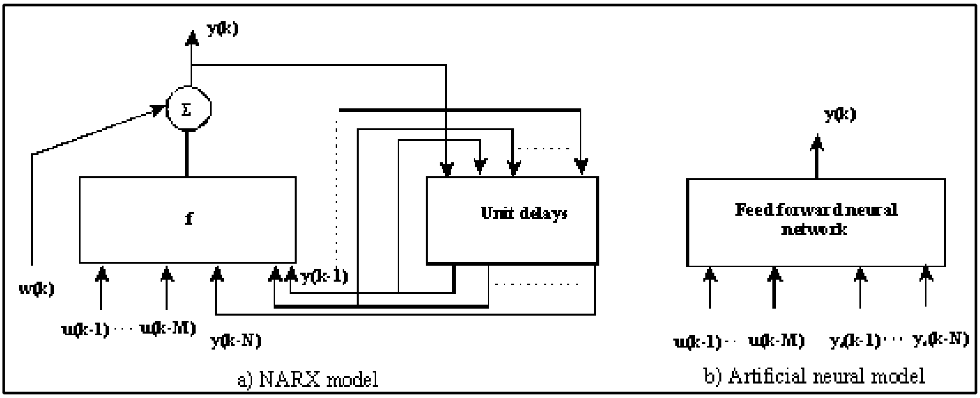

Fig. 2. Neural model used. [Source: [3], p. 10]

3. Results and conclusions

Artificial neural networks offer a way for process modelling and prognosis. They can be used for "black box" modelling, in processes or systems that can not be described by an analytical model. The authors studied more variants of neural networks synthesized for the modelling of some natural phenomena and, beginning with this modelling, for prognosis. Next, we present a part of the results obtained in the study of some geo-morphological processes. The inputs of the process were the rainfall and the output were the liquid and solid flow. We trained several neural networks with the values of these parameters and then we used the networks to forecast the solid and liquid flow in next two or three years. Some of our results are presented in figs. 3 and 4. The network in fig. 3. was a feed forward network with three layers, trained with dates in period 1979-1998.

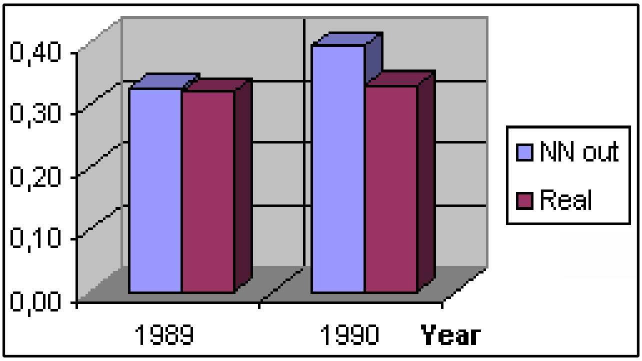

Fig. 3. Neural network forecast for solid flow

The network in fig.4. was also a three layers feed forward network, trained with dates in period 1979-1996.

The neural networks studied by the authors shown acceptable results in that concern the forecast values, but the accuracy is not very good. Some causes of such behaviour may be:

-The amount of available data about the studied phenomena
-The network structure and the delay order of the process used
-The training of the network, by usually backpropagation method, and not by backpropagation through time.

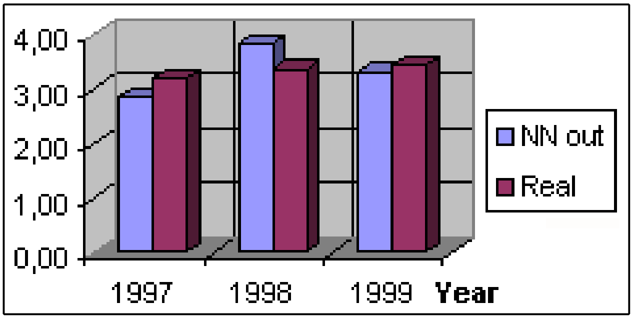

Fig. 4. Neural network forecast for liquid flow

REFERENCES

[1]. Dumitraş Adriana: *Proiectarea rețelelor neuronale artificiale,* Casa editorială Odeon, Bucureşti, 1997.

[2]. Dumitrescu D., Costin Hariton: *Rețele neuronale, teorie şi aplicații*, Editura Teora, 1996.

[3]. Ferreira D. Enrique: *Recurrent neural network models of multivariable dynamic systems: numerical methods and experimental evaluation*, Report, Carnegie Mellon University, 5 September, 1995.

[4]. Hassler Martin, Kamp Yves: *Reseaux de neurones récursifs pour mémoires associatives*, Presses Politechniques et Universitaires Romandes, Lausanne, 1994.

[5]. Khalid Marzuki, Omatu Sigem, Yusof Rubryat: *Temperature Regulation with Neural Network and Alternative Control Schemes,* I. E. E. E. Trasactions on Neural Networks, vol. 6, No. 3, May 1995.

[6]. Nerrand O., Roussel-Ragot P., Urbani D., Pernnaz L., Dreyfus G.: *Training Reccurent Neural Networks: Why and How ? An Illustration in Dynamical Process Modeling*, I. E. E. E.Trasactions on Neural Networks, vol. 5, No. 2, March 1994.

[7]. Park Young-Moon, Choi Myeon-Song, Lee Kwang Y.: *An Optimal Tracking Neuro-Controller for Nonlinear Dynamic Systems,* IEEE Transactons on Neural Network Vol.7, No. 5, september 1996, p. 1099-1110.

[8]. Sastry P. S., Santharam G., Unnikrishnan K. P.: *Memory Neural networks for Identification and Control of Dynamics Systems,* I. E. E. E. Transactions on Neural Networks, vol. 5. No. 2, March 1994, pag. 306-317.