IMPACT EVALUATION OF THE TOXIC AND BIOLOGIC ACTIVE ELEMENTS CONSUMED THROUGH FOOD CROPS ON THE CONSUMER`S HEALTH USING NUCLEAR METHODS AND NEURAL NETWORK TECHNIQUE

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Abstract

The main goal of the present research is to determine the extent to which industrial element pollutants are transferred to the crops. This will be achieved by using nuclear and related techniques, but also multivariate process to determine levels, pathways, and fate of toxic and non-toxic bioactive elements.

At the Flerov Laboratory of Nuclear Reactions (FLNR) were conducted experiments using gamma activation - at the microtron MT-25, and X-ray fluorescence analysis. The preliminary measurements effectuated in 2008 have shown that these methods are suitable for analyzing of different agricultural crop samples.

The heuristic determination of abnormal patterns by univariate statistical methods was performed. Further, in order to interpret the concentration data, multivariate statistical process was implemented using a variety of neural network techniques.

Introduction

Environmental pollution is a complicated issue. Since there are strict national and international regulations on the amount of contaminant allowable in different environmental media, models have been designed to determine the degree of pollution. The environmental data are collected by active or passive monitoring and analyzed by means of various methods including first principles, feature extraction and pattern recognition, and also neural networks.

Recent studies focusing on the preservation of our environment have shown, on a global scale, the considerable potential of analytical techniques and multivariate process as tools to understand the interrelationships existing between different environmental components.

This research investigates the potential application of neural network technology to forecast the concentrations of industrial pollutants beyond the origin source in relation with agricultural lands. Various solutions including mathematical algorithms implemented as software were used.

Neural Networks

A neural network is based on the working of the brain. The network is fed inputs and outputs and it tries to work out any connections or relationships between the two.

Since neural networks incorporate non-linear components they are suitable for modeling non-linear systems as weather systems and environmental conditions. Due to the complex nature of the variables associated with air modeling and the large array of non-linearity imposed by meteorological conditions and physical landscapes the neural network serves as a potential alternative to conventional air dispersion and regression type models.

The calculations of a neural network yield in the following way. In a multi-layer neural network model, the way complex behavior is simulated by the processing element, which is a software neuron, or node. The combined information is compared to a threshold and/or modified by a transfer function and then sent as output, which becomes input for any other processing nodes connected downstream. Given the correct data whose output is correlated with each input – a neural network is able to self-organize and subsequently predict an output for any input.

Example: Neural network modeling of crop pollution in the Tirgoviste region

The aim of this example is to show how neural network modelling was used in the Tirgoviste region to assess the main pollution agents in crops in comparison with tree leaves.Samples of cabbage lettuce and leaves of acacias (Robinia pseudacacia) trees grown in different locations of the local monitoring net were used in this investigation.

Accurate determination of trace concentration levels is an important task in agricultural sciences and their applications. Photon activation analysis (IPAA) supplemented by the X-ray fluorescence analysis using the ^{109}Cd (Eγ=22.16 keV) and ^{241}Am (Eγ=59.57 keV) radioisotop irradiation sources offered a reliable approach of providing a rapid multielemental analysis of various samples in ppm range, supposing as well the preservation of the samples.

Suggested analytical techniques were found as appropriate to measure concentrations of heavy metals in vegetation samples.

Suggested methodology mostly gives lower concentrations than in standard samples, high concentrations can be received in 1-2 cases from 5 for Cr, V, Ni.

Only 48.3% and 70% of standard concentrations are determined for Cd and Pb using the above methodology. Maximum determined concentrations of Cd and Pb were 64% and 76% from standards.

Neural network modelling by the Levenberg - Marquard algoritm

One of the major limitations of current methods of biological detection of exposure to hazardous environmental agents is their inability to detect long-term exposures, and exposures occurred in the past. In the current study we examined the potential of a neural network bioassay that is based on the hypothesis that organism of the exposed leaves contains a toxic factor.

The Levenberg - Marquard algoritm is adopted as training method; the run is stopped once the squared error on the validation dataset begins to increase. To test the model, weather forecasts were fed into the model 24 hours in advance and the pollution levels were checked. The run showing the lowest squared error is selected as optimal and then simulated on the testing set (Figs. 1 - 2).

To study the correlations (Fe – Co) – (Ti – V) a neuronal 2 – 7 – 2 simulation was performed. As training values the first 15 data sets and as test values the last 8 data sets were used. The best approximations for linear function (R = 0.922, R = 0.960) are presented in the Figures 1 and 2.

A component of Fe, Co, Ti and V characterized a general pollution agent in crops and tree leaves connected with urban anthropogenic activity of Tirgoviste town.

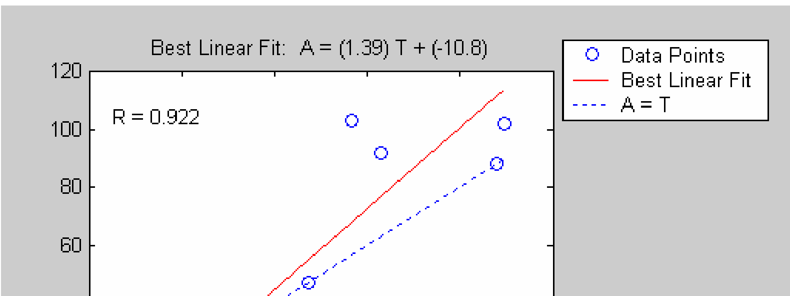

Fig. 1. Graphical representation of the experimental points versus regression line – Best Linear Fit – etalon line (A = T) for Ti concentration in cabbage lettuce leaves in the neuronal model adopted (Fe – Co) – (Ti)

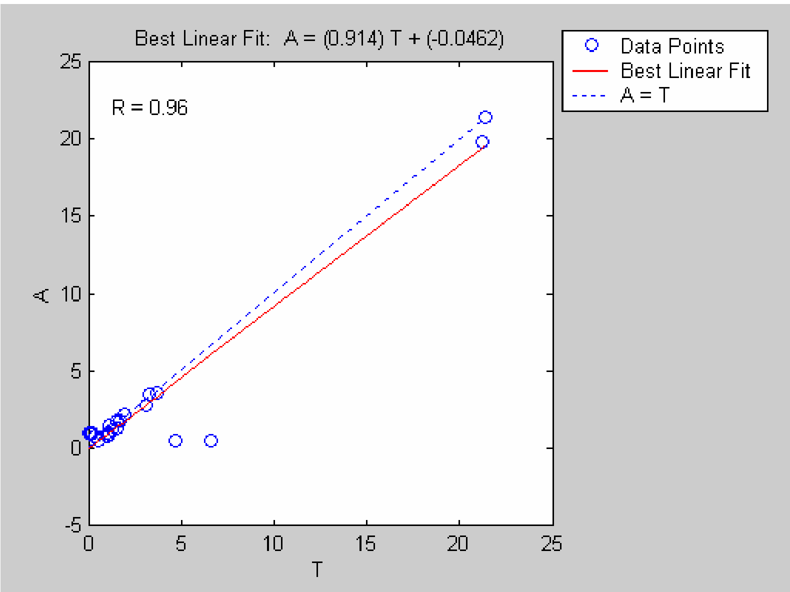

Fig. 2. Graphical representation of the experimental points versus regression line – Best Linear Fit – etalon line (A = T) for V concentration in tree leaves in the neuronal model adopted (Fe – Co) – (V)

Conclusions

It was obtained a good analytical recovery for most metals. The crops provided their capacities as biomonitors, but less than tree leaves.

We have shown that a neural network can reproduce output nearly identical to that produced by existing biomonitoring approaches. Furthermore, the results demonstrate the potential of the proposed methodology to detect environmental exposures long after they have occurred. It was notified the further decline heavy metal concentrations in tree leaves between 2000 and 2005; for crops, the situation is still unknown

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